Essays in Corporate Finance

Dissertation
for the Faculty of Economics, Business Administration and Information Technology of the University of Zurich

to achieve the title of
Doctor of Economics

presented by
Florian S. Peters
from Germany

approved at the request of
Professor Michel A. Habib
Professor Alexander F. Wagner

The Faculty of Economics, Business Administration and Information Technology of the University of Zurich hereby authorizes the printing if this Doctoral Thesis, without thereby giving any opinion on the views contained therein.

Zurich, April 2, 2008

The Dean: Prof. Dr. Josef Falkinger

Acknowledgements

The completion of a doctoral thesis is a task one could not hope to master without support, and mine is certainly no exception. The first, general remark I want to make is that I have had the good luck to be in an environment which allowed me to discover and pursue my very interests, and which provided an atmosphere of openness, flexibility, intellectual curiosity and ambition. Much of the professional and personal development I have gone through during this period would have been unthinkable without it.

I want to express my deep-felt gratitude to my adviser Michel Habib. It is difficult to imagine a more gentle, generous and intelligent person than him. His continuous encouragement and optimism have helped me develop the confidence and trust in myself and my ideas that are fundamental to doing good research. His guidance and comments on my work as well as his advice and support concerning the perspectives beyond my Ph.D. dissertation have been invaluable.

I would also like to take the opportunity to thank my co-adviser and co-author Alex Wagner. Since the start of our first joint project I experienced the joy and productivity that academic co-operation can bring about. It is rare to find oneself in a collaboration where backgrounds, interests and strengths complement each other to such an extent and where the common basis is yet broad enough for each to immediately understand the other. His confidence, experience, and knowledge were essential for bringing our joint work, and my dissertation, to a successful end.

Many other people have helped in different ways. I would like to mention Simon Broda and Loriano Mancini for their availability and patience in clarifying the many econometric questions I have had over the years. The great company of my classmates Anna, Yianna, Gorazd and Bogdan helped me master the challenging first year in the Ph.D. program. It will not be forgotten.

Finally, I would like to thank my brother Daniel and my parents Reiner and Jutta. Knowing me for the longest possible time - all my life - they were best able to understand my motives, aspirations, and emotional states during these years, and to smooth the ups and downs that came with writing a dissertation. They supported me every step of the way, in good as well as in tough times. Among the many things that would deserve mention, my mother was essential to my development because of her unyielding support and rock-solid trust in my capabilities. My father gave me invaluable guidance in internalizing a fundamental approach to research: to embrace results whichever way they come out, not to be concerned that the outcome may be disappointing, but to welcome any new insights, not only those that one expects or hopes for. My brother was a great inspiration because he has been a my best friend and a role-model for how a person can keep developing on the personal and interpersonal level.

Contents

Introduction

This thesis is divided into three chapters. The first two chapters investigate the empirical relevance of two distinct shareholder-debtholder conflicts, strategic default and asset substitution. Chapter 1 and 2 are related in that they are both concerned with capital structure-induced agency conflicts. The third chapter is dedicated to a different area of corporate finance, that of executive compensation and corporate governance.

Chapter 1 investigates the idea that concerns about strategic behavior of borrowers are reflected in corporate debt structure. An important insight of the incomplete contracts approach to corporate finance is that borrowers can have incentives to act opportunistically once debt is in place, trying to extract concessions from lenders even when cash flows are sufficiently high to service debt in full. A deliberate failure to perform the contractually stipulated debt service has been termed strategic default. In principle, this type of incentive problem exists whenever creditors can expect to suffer significant losses in case the borrowing firm is liquidated and if, in addition, debt can be renegotiated. In such a situation, lenders may agree to grant concessions on the terms of the loan, rather than risk to incur even bigger losses in liquidation. Rational lenders should anticipate such strategic behavior and limit the amount of debt they are willing to grant. Thus, such misalignment of incentives is costly, because it can reduce debt capacity and firm value.

By choosing a type of debt which is difficult or impossible to renegotiate, these costs can possibly be reduced. Issuing public debt is an effective way of introducing such renegotiation frictions. Due to coordination problems among its highly dispersed claimants, public debt is essentially renegotiation-proof. Hence, firms facing particularly severe incentive problems may use public debt as a commitment device allowing them to increase debt capacity. However, issuing renegotiation-proof debt comes at a cost. In cases of liquidity default, when cash flows are insufficient to service debt obligations, renegotiation flexibility is valuable as it makes reorganization more viable and thus increases the chances of avoiding inefficient liquidation. Moreover, renegotiation flexibility is particularly valuable for firms facing high liquidation costs, so precisely for those firms with the strongest incentives for strategic default. Thus, whether liquidation costs lead firms to rely more or less on public debt is an empirical question.

Answering this question is the task of Chapter 1. The evidence suggests that strategic considerations do not have a first order effect on the choice of public versus private debt. If anything, firms with asset structures that imply high liquidation costs tend to rely less, not more, on public debt. These findings suggest that ex-post efficiency (in terms of renegotiation flexibility) may be more important than ex-ante efficiency (in terms of incentive alignment) for corporate choice of creditor concentration. However, other interpretations are also conceivable. The lack of statistical robustness across regression specifications may indicate that the two effects largely offset each other. Yet another interpretation is that strategic default incentives may be addressed by mechanisms other than creditor dispersion.

Chapter 2 examines a classical agency conflict, the asset substitution problem, in a new light. The term asset substitution refers to the notion that leverage induces shareholders to increase asset risk at the expense of debtholders, by substituting less risky assets with more risky ones. The intuition of this hypothesis is founded on the analogy between a levered firm's equity and a financial call option, which generally increases in the riskiness of the underlying asset.

An important distinction between the approach taken in the present work and most of the existing literature, is that the hypothesis is tested directly, that is, the direct relation between asset risk and leverage is examined. Prior research has largely studied whether risk-shifting concerns are reflected in capital structure, thus providing only indirect evidence. The direct approach, however, poses two main challenges to the analysis. First, asset volatility needs to be accurately estimated. This is non-trivial as asset risk is in general unobserved. This issue is addressed by estimating asset risk as the volatility implied by structural credit risk models. A second concern is that the leverage-risk relation is subject to endogeneity. To alleviate endogeneity problems the analysis employs instrumental variables methods which exploit exogenous sources of variation in leverage.

The evidence indicates that a positive, causal relation between leverage and asset volatility exists. However, this relation is statistically and economically significant only for long-term leverage, that is when leverage is defined as the ratio of long-term debt to total assets or market value. Consistent with theoretical predictions about the role of debt maturity for risk-shifting incentives, this implies that long-term debt aggravates while short-term debt curbs risk-shifting incentives. Further results show that risk-taking incentives provided to management through incentive compensation as well as the ability to shift operational risks, as determined by the nature of the assets, are important factors exacerbating the asset substitution problem.

A main insight of this study is that the causal effect of leverage on firm risk (as identified by instrumental variables regressions) is positive even though the partial correlation between leverage and risk (as obtained from reduced form regressions) is negative. This suggests that asset risk generally decreases as firms take on higher levels of debt, but that this decrease is not as strong as it would be without the incentive effect of leverage. A practical implication of this finding is that creditors should anticipate the incentive effect of granting loans to their borrowers. Therefore, an interesting question left for future research is whether this incentive effect is priced in corporate bonds and loans.

Finally, chapter 3 proposes and analyzes a causal connection between executive compensation and forced CEO turnover. Executive compensation has increased dramatically over the past 15 years, but so has forced turnover. The close parallel development, not only regarding the general long-term evolution, but also the non-monotonic pattern after 2000, suggests that the two trends may be linked. Previous research shows that fired CEOs often suffer severe reductions of earnings opportunities later in their professional lives, and sometimes forfeit their previous compensation. I argue that these adverse consequences of forced turnover explain part of the secular rise and cross-sectional variation of CEO pay.

Two models are developed which each account for one of the two channels affecting the value of executive pay. Estimates obtained from these models indicate that monetary consequences of turnover can account for a 2 to 4 percent increase in total compensation for a one percentage point increase in turnover risk.

The empirical analysis reveals an even larger premium. For the CEOs of the largest US corporations for the years 1993-2001, a one-percentage point increase in the probability of involuntary turnover is associated with about 10 percent more in terms of total compensation. It is shown that this relation is unlikely to be driven by reverse causation or a general tendency towards stronger performance sensitivity of both pay and turnover. One interpretation of the divergence between the monetary costs of turnover and the empirical turnover risk premium is that non-monetary costs of forced turnover require additional risk premia. Another possible explanation draws on evidence from behavioral economics. Even though the historical average probability of forced turnover is small, CEOs may overestimate these probabilities as they represent an extreme event. Thus, probability weighting as proposed in cumulative prospect theory may lead executives to perceive turnover risk as much higher than it actually is, hence overstating the expected losses. Disentangling the various sources of the empirical premium for turnover risk is an interesting avenue for future research.

The proposed mechanisms and the empirical evidence on the executive turnover risk premium provide a new, powerful argument in the debate over the development of executive compensation. While much of the recent discussion in this area has been centered on the view that rising CEO pay is due to *weak* boards and managerial entrenchment, I propose a contrarian perspective, namely that it is precisely *strong*, assertive boards that lead to high pay, because CEOs need to be compensated for increased firing risk.

Chapter 1

Does Public Debt have Strategic Value? An Empirical Analysis

1.1 Introduction

This paper investigates the idea that concerns about strategic behavior of borrowers are reflected in corporate debt structure. An important insight of the incomplete contracts approach to corporate finance is that borrowers can have incentives to act opportunistically once debt is in place, trying to extract concessions from lenders even when cash flows are sufficiently high to service debt in full. In principle, this type of incentive problem exists whenever creditors can expect to suffer significant losses in case of liquidation. Because such strategic behavior requires renegotiation, renegotiation-proof debt may be used in order to align incentives and thus allow for higher debt capacity and firm value. Creditor dispersion is one way to create renegotiation frictions and, in the limit, preclude renegotiation altogether. Thus liquidation costs should be related to the degree of creditor dispersion. Of course, introducing renegotiation frictions improves ex-ante efficiency at the cost of ex-post efficiency. So ultimately, depending of which effect dominates, creditor dispersion may be positively or negatively associated with liquidation costs. This study takes firms' use of public debt as a measure of creditor dispersion and explores whether it can be explained by concerns over strategic behavior.

The results indicate that strategic considerations do not seem to have a first order effect on the choice between public and private debt. Even though statistical significance is in general weak and not robust across regression specifications, it appears that ex-post efficiency (in terms of renegotiation flexibility) is more important than ex-ante efficiency (in terms of incentive alignment) for the optimal degree of creditor dispersion. The proxies for liquidation costs have a sign opposite to that predicted by strategic default concerns in most of the regressions, and they consistently have the opposite sign when they are statistically significant. The lack of robustness of the results can be interpreted as indicating that the two effects approximately offset each other.

The incomplete contracts approach to capital structure pioneered by Aghion and Bolton (1992) and Hart and Moore (1994, 1998) has emphasized the difference between *liquidity default*, where the firm's cash flows are insufficient to honor the debt contract, and *strategic default*, where borrowers choose to default even when cash flows are sufficiently high. Incentives for borrowers to behave opportunistically are present whenever they can hope to extract concessions from creditors, such as a reduction of debt service or forgiveness of parts of the debt. In general, concessions are likely in situations when the creditor would be hurt more by enforcing the debt contract than by making such concessions. Anderson and Sundaresan (1996), Mella-Barral and Perraudin (1997) and Fan and Sundaresan (2000) analyze the effects of strategic behavior in the single-creditor case, a general prediction being that higher liquidation costs lead to lower debt capacities because lenders anticipate their weak bargaining position in a strategic renegotiation and hence limit the amount of funds they provide to the verifiable firm value, i.e. the liquidation value. If there are advantages to debt, such as a favorable tax treatment, lower debt capacity reduces firm value.

Given that a creditor's bargaining power in strategic renegotiations reduces debt capacity and firm value, value-maximizing firms should seek to limit their bargaining power ex ante, if such commitment is feasible. Bergman and Callen (1991), Bolton and Scharfstein (1996) and Hege and Mella-Barral (2005) argue that dispersed debt reduces the creditor's bargaining power in renegotiations because, due to coordination problems, this type of debt is more difficult to renegotiate or even renegotiation-proof. Hence, firms with high liquidation costs are hypothesized to rely more heavily on public, dispersed debt relative to private, concentrated debt.

Using a related argument Berglöf and von Thadden (1994) show that a complex capital structure with multiple classes of investors who hold claims that differ in maturity and seniority is more difficult to renegotiate than a simple capital structure with a single investor because externalities across the different classes of investors make the senior, short-term claim holders tougher in renegotiations. Hence, firms with high liquidation costs are predicted to have larger proportions of senior and short-term debt. In a related theoretical setting, Diamond (2004) derives similar predictions, namely that enforcement costs are positively associated with the proportion of short-term debt, the degree of externalities between lenders, and the optimal number of creditors. The common theme of the different theoretical approaches is that ex-post inefficiencies due to dispersed investors with conflicting interests increases ex-ante efficiency by discouraging strategic default.

While incomplete contracts models stress ex-ante efficiency of creditor dispersion, other authors view ex-post efficiency as more important. Bris and Welch (2005) argue that mutual free-riding incentives weaken the overall outcome of dispersed claimants, because they reduce collection or reorganization effort in default. Applied to the present setting this would imply that concentrated debt is preferable when liquidation costs are potentially high, a prediction opposite to that emerging from the incomplete contracts view. This is, indeed, one interpretation of the empirical results.

A large body of empirical literature analyzes the effects of conflicts among lenders from an *ex-post* perspective. Most of this literature focuses on distressed reorganizations under the U.S. Bankruptcy Code.[1] Franks and Torous (1989), Gilson et al. (1990), Franks and Torous (1994) and Helwege (1999) document that formal bankruptcy under Chapter 11 is lengthier and more costly than informal reorganization. Gilson et al. (1990) and Asquith et al. (1994) find that the probability of a successful out-of-court reorganization increases with a smaller number of debt contracts, larger proportions of bank debt, and lower proportions of secured debt. In addition, Betker (1995) shows that deviations from absolute priority, which also indicate negotiation flexibility, are larger when the fraction of secured or senior debt is lower. Although some studies have found conflicting results[2], taken together, the evidence seems to support the assumption of the cited theoretical models that a larger degree of creditor dispersion and the presence of various types of debt indeed complicate renegotiation.

In contrast, empirical evidence on the *ex-ante* perspective, i.e. the relation between the expected relative bargaining position and the choice of financial structure, is limited to the analysis of bank debt.[3] Detragiache et al. (2000), Ongena and Smith (2000) and Esty and Megginson (2004) provide cross-country evidence on the influence of creditor protection and the number of banking relationships. Davydenko and Franks (2004) study the relation between creditor rights and the degree and type of bank loan collateralization. Benmelech et al. (2004) investigate the link between liquidation values of commercial properties and characteristics of mortgage loans. In general, these papers find evidence consistent with bargaining-based theories, namely that firms which are likely to be in a strong bargaining position in renegotiations tend to have a larger number of bank relationships and more secured bank debt. Extending the evidence on the ex-ante perspective to the choice between public and private debt is the task of this paper.

Another contribution of this paper is the precision of the debt structure variables. I use a sample of 200 U.S. corporations for which I construct a unique, hand-collected data set on debt structure for fiscal year 2003. I use Mergent/Moody's database on corporate debt issues in combination with annual reports to determine, for each debt issue, whether it is private or public. The Mergent/Moody's database is very precise in this regard since it

[1]For evidence on bank debt restructuring in Germany see Brunner and Krahnen (2002)

[2]Franks and Torous (1994) do not find a significant relation between absolute priority deviations and the proportion of private debt or the number of debt issues. In a sample of junk bond issuers; Helwege (1999) even finds that higher fractions of bank debt increase reorganization time while the fraction of junk bonds shortens the period spent in default.

[3]In a related paper Davydenko and Strebulaev (2007) study whether variables that proxy for strategic actions are reflected in corporate credit spreads. As a measure for renegotiation frictions they also use, among other variables, the ratio of public to total debt. In their empirical specification they use the public debt ratio as an exogenous variable but mention that it may be endogenously determined.

records, for each debt issue, whether it has been publicly or privately placed, and whether privately placed issues have been registered with the Securities and Exchange Commission (SEC) subsequent to placement. Most prior studies on public versus private debt choice (Houston and James, 1996; Johnson, 1997) exclusively rely on annual reports in their classification of debt. However, companies are not required to report whether debt is publicly traded or privately held. Thus debt structure data collected from annual reports only is likely to be very noisy.

Besides the bargaining-based perspective, there are, of course, important other theoretical explanations for the choice between dispersed (public) and concentrated (private) debt. Accounting for these factors in the empirical specification is important as they may dominate the more subtle motives of strategic actions. The most prominent among these is a theory based on information asymmetries in which banks are assumed to have a comparative advantage in gathering relevant information about the borrower. Firms plagued with severe information asymmetries are predicted to borrow predominantly from banks since the adverse selection problems would lead to excessive costs of public debt. Transparent firms, on the other hand, prefer to borrow in the public debt markets to avoid bank monitoring costs. The models in Diamond (1989, 1991) build on this information-based argument. In these models reputational capital provides incentives to prevent moral hazard. Established, highly rated firms borrow in public debt markets as they have sufficient incentives to avoid moral hazard. Young, lower rated firms, on the other hand, need bank monitoring to provide them with such incentives.

Other theoretical approaches focus on banks' flexibility in making liquidation versus reorganization decisions (Chemmanur and Fulghieri, 1994; Berlin and Loeys, 1988). Firms with a higher likelihood of financial distress will value this flexibility more than low-risk firms and will hence be more prone to choose bank debt than safe firms. Further, there are reasons to expect a positive relation between firm size and reliance on public debt. As Blackwell and Kidwell (1988) and Fama (1985) point out, the high (fixed) issuance costs of public debt imply economies of scale which make it more costly for small firms to have public debt.

The rest of the paper is organized as follows. Section 1.2 develops in more detail the set of hypotheses to be tested. I extend the stylized predictions of theoretical models by relating debt structure to a creditor's expected loss given default. Section 1.3 describes the data collection procedure and the final data set. Section 1.4 presents the regression results. Section 1.5 offers concluding remarks.

1.2 Testable Hypotheses

The division of ex-post bargaining power between the borrower and the lender plays a central role in incomplete contract models of debt. In this theoretical framework a lender who expects himself to be in a weak ex-post bargaining position rationally anticipates the borrower's incentives for opportunistic behavior and hence limits the amount of funds he is willing to provide, at the extreme to the verifiable firm value, the liquidation value. If the firm would optimally borrow more than the offered amount, for instance because of tax advantages to debt, this ex-post incentive problem creates ex-ante inefficiency. Given the choice, the firm would seek to limit its own bargaining power in order to increase its debt capacity. Thus self-binding devices, if feasible, are relevant whenever the optimal amount of debt exceeds the verifiable firm value.

Bargaining power depends on a number of factors. First, it clearly depends on the consequences incurred when negotiations fail. A creditor's bargaining position, for instance, should be stronger the higher is the liquidation value of his claims relative to their continuation value. Second, if multiple creditors are involved, bargaining power should also depend on their ability and willingness to coordinate a response. In general, coordination problems should make creditors tougher in renegotiations since it is more difficult to obtain unanimous consent to deviate from the original terms of the contract. In the limit case, when creditors are highly dispersed, debt may be entirely renegotiation-proof.

Of course, other characteristics of debt also influence the ex-post division of bargaining power. Creditors of secured or high priority debt will be less willing to make concessions ex post, as their claims are unlikely to lose value in default. Also, creditors of short-term debt should be tougher in renegotiations as these claims are served before long-term debt of equal seniority. In this study I focus on public versus private debt use, but I address alternative interpretations and causalities related to seniority and maturity in the empirical section below.

Hege and Mella-Barral (2005), Bolton and Scharfstein (1996), and Bergman and Callen (1991) argue that publicly traded debt with its dispersed, atomistic bond holders complicates renegotiation due to free-rider problems whereas private debt, usually held by few, well-coordinated investors, is easier to renegotiate. Hence public debt is proposed as an appropriate commitment device against strategic behavior, and is predicted to be predominantly used by firms whose debt capacity with concentrated lenders would be low.

Of course, a main concern is that liquidation values affect the *total amount* of public debt for other reasons than strategic default. Firms with low liquidation values relative to total assets tend to be less levered in general, and so they also tend to have less public debt. I address this concern by using dependent variables that condition on the total amount of debt, first by analyzing only firms with strictly positive debt, and second by defining the public debt ratio as the ratio of public to total debt (rather than public debt to total assets). These arguments yield the first hypothesis.

HYPOTHESIS 1 (Liquidation values and the use of public debt):

1a. Given strictly positive leverage, public debt use is more likely when liquidation values are low.

1b. The public debt ratio is decreasing in liquidation value.

1c. Conditional on strictly positive leverage, firms have more complicated debt structures in terms of the number of outstanding public debt issues.

The models which yield Hypothesis 1 all assume some that debt is generally desirable, either because it is subject to favorable tax treatment (Bergman and Callen (1991), Hege and Mella-Barral (2005), or because it is simply necessary to fund a project (Bolton and Scharfstein (1996)). However, it has been argued, most notably by Myers (1984), that tax benefits may not play as important a role as assumed in much of the capital structure literature. In addition, some firms may be able to finance their investments with internally generated cash flows and thus do not depend on debt finance. The hypothesis below is analogous to Hypotheses 1 except that it is independent of the underlying motives for debt finance, but rather takes the amount of debt as given. As argued above, strategic considerations and commitment become increasingly important the more debt value exceeds liquidation value. If tangible assets are taken as a proxy for the liquidation value, then the positive part of the difference between total debt and tangible assets is an upper bound of the loss to creditors in case renegotiation fail. Whenever tangible assets exceed total debt borrowers are unlikely to make any concessions in a renegotiation since the liquidation value would most likely cover their claims. On the other hand, when debt exceeds tangible assets, creditors are more likely to suffer significant losses in a liquidation, and hence are more willing to make concessions. As a consequence, one should expect that self-commitment is only relevant when total debt exceeds tangible assets, and only that portion of total debt exceeding tangible assets should be renegotiation-proof or public. Thus we have

HYPOTHESIS 2 (Loss given default and the use of public debt):

2a. Public debt use is more likely when creditors' loss given default is positive.

2b. The public debt ratio is increasing in creditors' loss given default as a fraction of total debt.

2c. Firms have more complicated debt structures in terms of the number of outstanding public debt issues when creditors' loss given default is positive.

1.3 Data Description

1.3.1 Data Sources and Sample Selection

This study analyzes a sample of established, medium-sized, and publicly traded U.S. corporations which are constituents of the Russell MidCap Index as of May 31, 2003, the reconstitution date of the index for that year. The choice of U.S. data has several reasons. The first is that the evidence on renegotiation frictions in distressed reorganizations to which the bargaining theories of capital structure are tailored almost exclusively builds on U.S. data. Second, strategic actions are likely to be more relevant in countries where legal protection of creditors is relatively weak, because the losses creditors incur in case of liquidation are likely to be more severe in this case. By international comparison U.S. bankruptcy law is considered to be particularly debtor-friendly (Franks et al., 1996; La-Porta et al., 1998). In this respect it is topped only by the U.K. bankruptcy code. Third, in developed, market-based economies, such as that of the U.S., public debt plays a more important role than it does in bank-based systems. If dispersion of creditors is indeed important as a commitment device, it is more likely in market- than in bank-based economies that this will be reflected in the use of public debt. In bank-based systems, the same purpose may primarily be achieved through multiple bank relationships and syndicated loans rather than public debt issuance.

The analysis is restricted to established corporations because firms should have, in principle, access to public debt markets. On the other hand, I choose to focus on medium-sized companies because many of the largest U.S. corporations entirely rely on public debt. Including these firms would result in little variation of the dependent variables.

The initial sample comprises all 800 companies of the Russell MidCap index as of May 31, 2003. Financial firms (SIC codes 6000-6999), utilities (SIC codes 4900-4999), and firms with no debt outstanding are excluded. Of the remaining sample I retain only those firms for which data is available on COMPUSTAT research and active files. I merge the resulting data set with analyst forecast data from I/B/E/S. Further, I require that each sample firm have at least five analyst estimates for fiscal year ends 2000-2002 available in the I/B/E/S database.

For the remaining firms I hand-collect detailed information on debt structure from both 10-K filings and Moody's/Mergent Industrial Manuals. The data collected includes the respective amounts of several types of debt (public debt, bank debt, privately placed bonds, commercial paper, mortgage debt, capitalized leases, and industrial revenue bonds), the number of public debt issues, and whether the firm has multiple bank relationships. The Moody's/Mergent database provides detailed information on the type of each debt issue. For the vast majority of the bond issues in the sample it identifies whether they have been publicly issued or privately placed, and whether and when privately placed bonds have been registered with the SEC. I classify as public debt all bonds that have initially been publicly issued as well as private placement bonds that have been registered until fiscal year end 2003. Total debt is defined as short plus long term debt less capitalized lease obligations, industrial revenue bonds and mortgage debt. I only retain firms in the sample for which I can identify reliably more than 90% of total debt. This yields a final sample of 200 firms[4].

1.3.2 Dependent Variables

I define three variables that proxy for the degree of creditor dispersion. The first measure is a dummy variable for public debt use, *public debt dummy*, which equals one if the firm has public debt outstanding and zero otherwise. The reason for this definition is that even a small amount of publicly traded debt may complicate the renegotiation process considerably while variations in the public debt ratio conditional on its presence may have little additional effect.

The second measure is the ratio of public to total debt, *public debt ratio*. Controlling for size and leverage, firms with high proportions of public to total debt have a creditor structure which is more dispersed than for firms with lower public debt ratios.

The third measure is the *number of bond issues*. Some bond issues, even if publicly traded, may be in the hands of only a few institutional investors. This is particularly likely for privately placed bonds that are successively registered with the SEC. Firms with many different bonds outstanding are less likely to have concentrated bond holders. In addition, different debt issues virtually always differ in at least one of the main features,

[4]Exclusion of financial firms and regulated utilities resulted in a deletion of 233 firms. Of the remaining firms 59 had no debt outstanding at fiscal year end 2003. The match with the I/B/E/S database resulted in 275 deletions. Finally, there were 33 firms for which I could not reliably identify more than 90% of the debt.

seniority, maturity or coupon. As investors usually have distinct preferences regarding these characteristics, it is unlikely for the same investor(s) to hold different bonds of the same corporation.

1.3.3 Independent Variables

In order to test Hypotheses 1 and 2, below I define variables that proxy for liquidation values and loss given default. A weak bargaining position of creditors in a renegotiation is implied by a low liquidation value or a high loss given default.

Liquidation value. I use three variables to proxy for the costs of liquidation: The first proxy is the *market-to-book* ratio, defined as the sum of the book value of debt and the market value of equity, divided by the book value of total assets. *Market-to-book* is inversely related to liquidation values as firms with high market-to-book ratios derive most of their values from growth option which are lost in liquidation. As a second proxy I use the *fixed assets ratio*, defined as the ratio of fixed to total assets. Finally, I use the ratio of *R&D* expenditures to sales.

Loss given default. To estimate the losses that are likely to be incurred by creditors should they decide to liquidate the firm upon default, I define the proxy *loss given default* as $\max\{0, (\text{total debt} - \text{fixed assets})/\text{total debt}\}$. This variable is zero for firms whose debt does not exceed the book value of tangible assets. Assuming that tangible assets proxy for the liquidation value, a commitment problem does not exist for these firms, and public debt should have no strategic value. Positive values of the variable measure the fraction of total debt that exceeds tangible assets. The greater is this fraction, the more severe is the commitment problem and the higher may be the strategic value of public debt.

I now turn to the definitions of the control variables which account for other important motives for the choice between public and private debt.

Economies of scale. I use two variables that measure the economies of scale in flotation costs of public debt, firm *size* and *leverage*. Issuance costs of public debt typically contain a large fixed component (Bhagat and Frost, 1986; Smith, 1986; Blackwell and Kidwell, 1988) implying significant economies of scale. Thus firm size and leverage should be factors favoring the use of public debt. I measure firm size by the logarithm of total assets and use book values to calculate leverage.

Information asymmetries and reputation. The presence of information asymmetries in debt markets is probably the most prominent explanation for financial interme-

Table 1.1: Variable Definitions.

Variable	Definition	Characteristic	Data Source
	PANEL A: Dependent Variables		
Public debt dummy	Dummy variable indicating firm's use of public debt.	Creditor dispersion	Mergent/Moody's
Public debt ratio	Fraction of public debt to total debt	Creditor dispersion	Mergent/Moody's, 10-K
Number of bond issues	The number of public bond issues	Creditor dispersion	Mergent/Moody's
	Panel B: Independent Variables		
Size	Logarithm of total assets	Economies of scale	COMPUSTAT
Leverage	Book value of total debt/total assets	Economies of scale	COMPUSTAT
Forecast error	$\lvert \mathrm{mean}(\widehat{EPS}) - EPS\rvert / \lvert EPS\rvert$	Information asymmetry	I/B/E/S
Forecast dispersion	$\mathrm{std}(\widehat{EPS})/\lvert EPS\rvert$	Information asymmetry	I/B/E/S
Age	Years since the firm's initial public listing	Reputation	COMPUSTAT
Idiosyncratic risk	Volatility of excess equity returns relative to the Russell 3000 index	Default risk	Datastream
Market-to-book	(Market value of equity + book value of debt)/total book assets	Liquidation value	COMPUSTAT
Fixed assets ratio	Net property, plant, and equipment/total assets	Liquidation value	COMPUSTAT
R&D	Research and development expenditures/total sales	Liquidation value	COMPUSTAT
Loss given default	$\max\{0, (\text{total debt} - \text{fixed assets})/\text{total debt}\}$	Creditor's liquidation loss	COMPUSTAT
Debt≤3 years	Fraction of total debt maturing within three years from 2003	Agency Costs	COMPUSTAT

diation, i.e. the use of private debt. Private lenders are thought to have a comparative advantage with respect to public bond holders in collecting relevant information ex-ante and monitoring the borrower ex-post (Leland and Pyle, 1977; Diamond, 1984). Firms with larger information asymmetries are hypothesized to rely more on private debt and less on public debt. I employ two measures of information asymmetry that are based on the accuracy of financial analysts forecasts of earnings per share (EPS). Following Best and Zhang (1993) I calculate the percentage *forecast error*, defined as the absolute value of the difference between the mean EPS forecast made in the final month of fiscal year 2003, divided by the absolute value of the actual EPS for that year. Akin to Krishnaswami and Subramaniam (1999) and Thomas (2002) I use as a second measure of information asymmetry the *forecast dispersion*, defined as the standard deviation of earnings forecasts for the respective fiscal year end, normalized by the absolute value of actual earnings for that year.

Finally, I use the firm's *age*, defined as the years since the first public listing, as a proxy for reputation. This is motivated by an argument developed by Diamond (1991), where reputational capital provides borrowers with incentives to refrain from committing moral hazard. The model makes a life-cycle prediction about the use of the different debt sources in which younger firms borrow from private lenders and older firms borrow directly in the public debt markets.

Default Risk. A number of models have emphasized the flexibility and efficiency of renegotiation in a liquidity default as an important advantage of private debt (Berlin and Loeys, 1988; Chemmanur and Fulghieri, 1994; Detragiache, 1994). Firms with a higher probability of financial distress will value this flexibility more than low-risk firms and are thus predicted to rely more heavily on private debt.

I use *Idiosyncratic risk*, defined as the volatility of excess equity returns relative to the market return as a measure of default risk. The results however, are not materially affected if I use total volatility instead. Campbell and Taksler (2003) demonstrate that market-adjusted idiosyncratic volatility seems to be orders of magnitude more important for explaining credit spreads (which contain a default risk premium) than market volatility. In addition, Avramov et al. (2004) show that the link between idiosyncratic volatility and credit spreads is especially strong for low-rated bond classes where credit spreads are mainly driven by default risk. Combining this evidence suggests that idiosyncratic volatility is a predominant firm-specific factor determining default probabilities.[5] *Idiosyncratic risk* is

[5]Of course, combining a number of relevant factors can lead to a more accurate measure of credit risk.

computed from weekly equity prices for the three years preceding the sample year. As the benchmark market return I use the Russell 3000 index. Of course, the variables *size* and *age* are also correlates of default risk.

Agency costs. An important issue for the analysis is to control for the potential endogeneity of the main variables of interest, the market-to-book ratio, the fixed assets ratio and the ratio of R&D expenditures to sales. Besides proxying for the relative bargaining power of the firm vis-à-vis its borrowers, these variables are closely connected to the firm's growth opportunities. Myers (1984) argues that risky debt can induce shareholders in some states to reject positive net present value projects because the benefits accrue mostly to debtholders. This underinvestment problem can be controlled, among other things, by shortening the maturity of the debt claims. Specifically, if the debt matures before the investment opportunity expires, suboptimal investment incentives are eliminated. Thus firms with abundant growth opportunities are expected to have smaller proportions of long-term debt in their capital structure. Barclay and Smith (1995b) and Stohs and Mauer (1996) find empirical support for this hypothesis. Since public debt is usually long-term and private debt is predominantly short-term, this can induce the main variables to be biased. I control for this potential endogeneity by including the ratio of *short-term debt* to total debt in the regressions. Following Barclay and Smith (1995b), I define short term debt as debt maturing within three years from the sample year.

A second potential source of endogeneity is the close link between priority structure and the choice between private and public debt. Most secured debt is privately held while public debt is usually unsecured. Stulz and Johnson (1985) argue that the underinvestment problem can also be reduced if the firm reserves the right to finance new investment projects with high priority debt. Thus firms with more growth options should have a higher fraction of high priority claims in their capital structure. Empirical support for this hypothesis was found by Barclay and Smith (1995a). I control for this source of endogeneity by excluding the highest priority claims, capitalized leases and mortgages from the definition of total debt.

1.3.4 Summary Statistics

Table 1.2 presents summary statistics of the main variables. As regards debt structure, most of the sample firms (181) have a positive amount of public debt outstanding, while

---

However, in this study common factors such as the yield curve slope and general market conditions are the same for all firms.

only 28 firms rely entirely on private debt. The median fraction of public debt is very high, 87% in the entire sample, and 90% in the subsample that conditions on a positive amount of public debt. Firms with public debt outstanding have a median of three debt issues, while the variation is very high, ranging from zero to 19 debt issues at the 5% and 95% quantile, respectively. Surprisingly, the percentage of debt maturing in less than three years is larger for firms that have public debt outstanding than for those without public debt. This may be particular to the small sample size of firms that have private debt only.

As expected, the median firm with public debt outstanding is much larger and more highly leveraged than the median firm whose debt is exclusively provided by private lenders. Analysts' forecast errors and dispersion do not seem to vary much across the two subsamples. The median number of years a firm has been publicly listed is significantly larger for firms that use public debt. There does not seem to be a significant difference in idiosyncratic risk between companies with and without public debt. This is somewhat surprising as one would expect firms with public debt to be less risky. The insignificance of the difference may be due to the development of junk bond markets which allow even relatively risky firms to obtain funds at competitive rates.

Regarding the proxies for strategic factors the results show that firms with private debt also have higher market-to-book ratios than their counterparts. This is consistent with Myers' (1984) prediction that these firms should be less leveraged and therefore less likely to incur the high costs of public debt issuance. The fixed assets ratio does not vary significantly across the two subsamples. The fractions of R&D expenditures per sales are low in both subsamples, the variation, however, is much larger in the sample of firms which rely exclusively on private debt. This implies that those firms with the highest R&D intensity avoid the increased disclosure implied by public bond issues.

1.4 Empirical Results

This section presents the regression results for the three different specifications of the dependent variable, a dummy variable which indicates the use of public debt, the ratio of public to total debt, and the number of public debt issues.

1.4.1 The Use of Public Debt

Table 1.3 presents the results of regressions estimating the probability of public debt use. First, note that all control variables have the predicted sign. The coefficients of size and

Table 1.2: Summary Statistics. This table reports summary statistics on the main variables. *Use of public debt* is a dummy variable which equals one if the company had public debt outstanding at fiscal year end 2003 and zero otherwise.*Public to total debt* is the ratio of public to total debt. *# of public debt issues* is the number of public bond issues outstanding at fiscal year end 2003. *Total assets* is the total book value of assets in billion dollars. *Leverage* is the ratio of total debt to total book value of assets. *Forecast error* is the absolute value of the difference between the mean earnings forecast, made in the final month of the fiscal year end, and the actual earnings, divided by the absolute value of actual earnings as provided by I/B/E/S. *Forecast dispersion* is the standard deviation of earnings forecasts made in the final month of the fiscal year end, normalized by the absolute value of the actual earnings. *Age* is the number of years since the company's first public listing. *Idiosyncratic risk* is the volatility of excess returns relative to the Russell 3000 Index, calculated from weekly prices for the three years prior to the sample year. *Market-to-Book* is the ratio of the sum of book value of debt and market value of equity and the book value of assets. *Fixed assets ratio* the ratio net property, plant, and equipment to total assets. *R&D* is the ratio of research and development expenditures to total sales. *Debt≤3 years* is the fraction of debt maturing in less than or equal to three years. *Loss given default* are calculated as $\max\{0, (\text{Debt} - \text{Fixed Assets})/\text{Debt}\}$. *Total assets*, *Leverage*, *Forecast Error*, *Forecast Dispersion*, *Market-to-Book*, *Non-fixed Asset*, *R&D*, *Loss given default* and *Debt≤3 years* are averaged over the three years preceding the sample year 2003.

	Total Sample					Firms with Public Debt					Firms with no Public Debt				
Variable	Median	Std	5%	95%	N	Median	Std	5%	95%	N	Median	Std	5%	95%	N
Use of public debt	1.00	0.34	0.00	1.00	209	1.00	0.00	1.00	1.00	181	0.00	0.00	0.00	0.00	28
Public debt ratio	0.87	0.34	0.00	1.00	209	0.90	0.19	0.49	1.00	181	0.00	0.00	0.00	0.00	28
# of public debt issues	3.00	6.92	0.00	19.00	209	4.00	7.19	1.00	21.05	181	0.00	0.00	0.00	0.00	28
Debt≤3 years	0.24	0.26	0.00	0.94	173	0.24	0.24	0.00	0.78	150	0.19	0.38	0.00	1.00	21
Total Assets ($ bn)	3.44	6.41	1.15	16.44	209	3.98	6.56	1.27	16.60	181	1.80	1.28	0.76	5.74	28
Leverage	0.27	0.14	0.04	0.52	209	0.29	0.13	0.11	0.52	177	0.09	0.13	0.00	0.44	28
Forecast error	0.05	0.51	0.01	0.65	209	0.06	0.32	0.01	0.64	176	0.04	0.91	0.00	3.07	27
Forecast dispersion	0.03	0.12	0.01	0.25	209	0.03	0.12	0.01	0.28	176	0.03	0.05	0.01	0.16	27
Age	30	8.96	7.50	30.00	209	30.00	9.09	7.00	30.00	178	21.5	8.27	8.00	30.00	28
Idiosyncratic volatility	0.05	0.03	0.03	0.12	203	0.05	0.03	0.04	0.11	172	0.05	0.03	0.03	0.15	28
Market-to-book	1.58	1.06	1.01	3.49	207	1.51	1.06	1.01	347	176	2.43	0.92	1.15	4.32	28
Fixed assets ratio	0.28	0.20	0.07	0.75	209	0.28	0.20	0.07	0.75	178	0.26	0.21	0.06	0.75	28
R&D	0.02	0.06	0.00	0.19	134	0.02	0.06	0.00	0.17	113	0.01	0.09	0.00	0.32	19
Loss given default	0.00	0.27	0.00	0.78	200	0.00	0.28	0.00	0.78	170	0.00	0.24	0.00	0.71	28

leverage are positive and highly significant. The forecast error and dispersion, the proxies for information asymmetry, significantly decrease the likelihood of a company holding public debt. The coefficient of age is non-negative but very close to zero and insignificant. The insignificance of company age may be due to the definition of the proxy for age, which measures the years since public listing and not the years since first incorporation. Thus even the firms with the lowest values for *age* are already quite established and additional variation in age may not have a significant effect. Finally, the proxy for default risk, idiosyncratic volatility, seems to have a negative impact on the decision to issue public debt even though it is not statistically significant at conventional levels. The control variable for the fraction of debt maturing is not significant. This is surprising but consistent with the univariate results in Table 1.2.

The proxies for liquidation values, the market-to-book ratio, the fixed assets ratio, and R&D expenditures are all insignificant. This suggests that, controlling for the level of leverage, the liquidation value is not a significant determinant for a company to have public debt in its capital structure. On the other hand, the proxy for loss given default is statistically significant, but has a negative sign, contrary to Hypothesis 2. This means that firms whose book value of debt exceeds tangible assets are less likely to have public debt, or more likely to rely on private debt only. Though the evidence is relatively weak, it indicates that strategic considerations do not appear to have a first order effect for the choice of public debt. To the contrary, it seems that, if anything, the ex-post inefficiency of public debt weakly dominates the ex-ante efficiency, and so firms with few tangible assets prefer private debt possibly to increase renegotiation efficiency is case of default.

1.4.2 The Ratio of Public to Total Debt

I now turn to the analysis of the determinants of the public debt ratio. Table 1.4 presents the results. For the control variables I find similar results as in the Probit regressions of Table 1.3. *size* and *leverage* are both significant and enter with the expected sign. *Forecast error* and *forecast dispersion* have the expected negative sign but are insignificant in all regressions. Contrary to the Probit regressions of the precedent subsection which suggests that *age* does not determine whether firms have public debt or not, Table 1.4 indicates that firm age does seem to be an important determinant for how much public debt firms have as a fraction of total debt.

The key result is that liquidation values and loss given default are not significant determinants of the public debt ratio. All coefficients are insignificant and, except for R&D

Table 1.3: Probit regressions estimating the use of public debt. The dependent variable is a dummy variable which equals one if the company had public debt outstanding at fiscal year end 2003 and zero otherwise. *Size* is the logarithm of total assets. *Leverage* is the ratio of total debt to total book value of assets. *Forecast error* is the absolute value of the difference between the mean earnings forecast, made in the final month of the fiscal year end, and the actual earnings, divided by the absolute value of earnings as provided by I/B/E/S. *Forecast dispersion* is the standard deviation of earnings forecasts made in the final month of the fiscal year end, normalized by the absolute value of the actual earnings. *Age* is the number of years since the company's first public listing. *Idiosyncratic volatility* is the volatility of excess returns relative to the Russell 3000 Index, calculated from weekly prices for the three years prior to the sample year. *Market-to-book* is the ratio of the sum of book value of debt and market value of equity to the book value of assets. *Fixed assets ratio* is net property, plant, and equipment divided by total assets. *R&D* is research and development expenditures divided by total sales. *Debt≤3 years* is the fraction of debt maturing in less than or equal to three years. All independent variables except *Age* are averaged over the three years preceding 2003. P-values are reported in parentheses.

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flotation Costs									
Size	+	1.66	1.99	1.72	1.97	1.24	1.58	1.43	1.63
		(0.01)	(0.00)	(0.03)	(0.00)	(0.04)	(0.00)	(0.05)	(0.00)
Leverage	+	5.18	5.21	5.22	5.96	3.83	4.04	3.69	5.16
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
Information Asymmetry and Reputation									
Forecast Error	−	−1.34	−1.33	−1.48	−1.28				
		(0.00)	(0.00)	(0.00)	(0.00)				
Forecast Dispersion	−					−2.98	−3.11	−4.10	−3.23
						(0.00)	(0.00)	(0.00)	(0.00)
Age	+	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.00
		(0.92)	(0.75)	(0.15)	(0.93)	(0.92)	(0.86)	(0.15)	(0.92)
Default Risk									
Idiosyncratic Volatility	−	−7.44	−6.37	−10.56	−7.01	−6.13	−5.24	−9.39	−5.72
		(0.12)	(0.18)	(0.16)	(0.14)	(0.18)	(0.24)	(0.18)	(0.21)

(continued)

(Table 1.3 continued)

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidation Values and Loss given default									
Market-to-Book	+	−0.25				−0.24			
		(0.23)				(0.22)			
Fixed Assets Ratio	+		0.00				−0.56		
			(0.99)				(0.43)		
R&D	+			−1.27				−1.22	
				(0.64)				(0.64)	
Loss given default	+				−0.89				−1.20
					(0.13)				(0.03)
Agency costs									
Debt≤3 years	−	0.21	0.23	0.05	0.20	−0.74	−0.08	−0.26	−0.11
		(0.68)	(0.64)	(0.93)	(0.68)	(0.19)	(0.86)	(0.64)	(0.81)
Pseudo-R^2		0.34	0.33	0.34	0.34	0.27	0.25	0.24	0.28
N		167	167	110	167	167	167	110	167

Table 1.4: Tobit regressions estimating the ratio of public to total debt. The dependent variable is the ratio of public to total debt. *Size* is the logarithm of total assets. *Leverage* is the ratio of total debt to total book assets. *Forecast error* is the mean earnings forecast, made in the final month of the fiscal year end, less actual earnings, divided by the earnings as provided by I/B/E/S, in absolute value. *Forecast dispersion* is the standard deviation of earnings forecasts made in the final month of the fiscal year end, normalized by the absolute value of the actual earnings. *Age* is the number of years since the first public listing. *Idiosyncratic volatility* is the volatility of excess returns relative to the Russell 3000 Index. *Market-to-book* is the ratio of the sum of book value of debt and market value of equity to the book value of assets. *Fixed assets ratio* is net property, plant, and equipment divided by total assets. *R&D* is research and development expenditures divided by total sales. *Debt$\leq$3 years* is the fraction of debt maturing in less than three years. All independent variables are averaged over the three years preceding 2003. P-values are reported in parentheses.

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flotation Costs									
Size	+	0.22	0.28	0.25	0.27	0.21	0.27	0.24	0.26
		(0.05)	(0.00)	(0.05)	(0.00)	(0.05)	(0.00)	(0.08)	(0.00)
Leverage	+	0.41	0.38	0.62	0.45	0.39	0.36	0.58	0.44
		(0.09)	(0.12)	(0.05)	(0.07)	(0.11)	(0.15)	(0.08)	(0.08)
Information Asymmetry and Reputation									
Forecast Error	−	−0.10	−0.09	−0.10	−0.09				
		(0.11)	(0.15)	(0.15)	(0.16)				
Forecast Dispersion	−					−0.21	−0.19	−0.13	−0.18
						(0.45)	(0.48)	(0.73)	(0.51)
Age	+	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
		(0.10)	(0.07)	(0.23)	(0.08)	(0.11)	(0.08)	(0.25)	(0.09)
Default Risk									
Idiosyncratic Risk	−	−0.31	−0.16	−1.71	−0.15	−0.34	−0.19	−1.84	−0.19
		(0.78)	(0.89)	(0.34)	(0.89)	(0.76)	(0.86)	(0.31)	(0.87)

(continued)

(Table 1.4 continued)

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidation Costs and Loss given default									
Market-to-Book	+	−0.05				−0.04			
		(0.29)				(0.34)			
Fixed Assets Ratio	−		0.05				0.08		
			(0.73)				(0.59)		
R&D	+			0.35				0.31	
				(0.62)				(0.67)	
Loss given default	+				−0.11				−0.13
					(0.34)				(0.27)
Agency costs									
Debt$\leq$3 years	−	−0.12	−0.12	−0.12	−0.12	−0.15	−0.15	−0.16	−0.14
		(0.33)	(0.32)	(0.43)	(0.33)	(0.22)	(0.23)	(0.29)	(0.23)
R^2		0.11	0.11	0.12	0.11	0.10	0.10	0.10	0.11
N		166	166	110	166	166	166	110	166

Table 1.5: OLS regressions estimating the number of public debt issues. The dependent variable is the number of public debt issues outstanding at fiscal year end 2003.*Size* is the logarithm of total assets. *Leverage* is the ratio of total debt to total book value of assets. *Forecast error* is the absolute value of the difference between the mean earnings forecast, made in the final month of the fiscal year end, and the actual earnings, divided by the absolute value of earnings as provided by I/B/E/S. *Forecast dispersion* is the standard deviation of earnings forecasts made in the final month of the fiscal year end, normalized by the absolute value of the actual earnings. *Age* is the number of years since the company's first public listing. *Idiosyncratic volatility* is the volatility of excess returns relative to the Russell 3000 Index, calculated from weekly prices for the three years prior to the sample year. *Market-to-book* is the ratio of the sum of book value of debt and market value of equity to the book value of assets. *Fixed assets ratio* is net property, plant, and equipment divided by total assets. *R&D* is research and development expenditures divided by total sales. *Debt≤3 years* is the fraction of debt maturing in less than or equal to three years. All independent variables except *Age* are averaged over the three years preceding 2003. P-values are reported in parentheses.

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flotation Costs									
Size	+	10.17	9.66	9.35	9.58	10.20	9.73	9.71	9.56
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Leverage	+	8.97	8.09	4.98	11.57	8.87	8.13	5.32	11.68
		(0.00)	(0.00)	(0.21)	(0.00)	(0.00)	(0.01)	(0.18)	(0.00)
Information Asymmetry and Reputation									
Forecast Error	−	−1.23	−1.12	−1.34	−1.08				
		(0.11)	(0.14)	(0.10)	(0.15)				
Forecast Dispersion	−					−3.01	−4.45	−6.34	−3.24
						(0.39)	(0.19)	(0.17)	(0.34)
Age	+	0.12	0.12	0.13	0.11	0.12	0.12	0.14	0.11
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Default Risk									
Idiosyncratic Risk	−	6.35	6.62	7.20	6.51	6.22	6.72	4.93	6.37
		(0.66)	(0.64)	(0.74)	(0.64)	(0.67)	(0.63)	(0.82)	(0.65)

(continued)

(Table 1.5 continued)

Independent Variable	Predicted Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liquidation Costs and Loss given default									
Market-to-Book	+	0.05				0.11			
		(0.93)				(0.85)			
Fixed Assets Ratio	−		5.29				5.81		
			(0.01)				(0.00)		
R&D	+			−12.49				−11.69	
				(0.16)				(0.19)	
Loss given default	+				−4.31				−4.49
					(0.00)				(0.00)
Agency costs									
Debt≤3 years	−	0.98	0.98	−0.37	1.01	0.60	0.64	−0.81	0.67
		(0.53)	(0.52)	(0.84)	(0.51)	(0.70)	(0.67)	(0.66)	(0.65)
R^2		0.41	0.44	0.37	0.44	0.40	0.44	0.36	0.44
N		167	167	110	167	167	167	110	167

expenditures, have a sign opposite to that expected. A possible interpretation for this result is that the ex-ante efficiency and the ex-post inefficiency effects of public debt essentially offset each other.

1.4.3 The Number of Public Debt Issues

Finally, I examine whether liquidation values and loss given default have an effect on the complexity of public debt structure. I use the number of public debt issues as a measure of additional capital structure complexity, because multiple debt issues are typically associated with multiple classes of investors with differing interests. This should make agreements in renegotiations more difficult and renegotiation success less likely. The results are reported in Table 1.5. Overall, most of the explanatory variables are highly significant and the explanatory power of these variables is quite high with an adjusted R^2 ranging between 36 and 41%. Of the control variables, *size*, *age*, and *leverage* are most significantly associated with the number of bonds outstanding and explain a large part of the sample variation of the dependent variable.

Except for the market-to-book ratio, the coefficients of the strategic variables have the opposite sign to the one predicted by Hypotheses 1 and 2. More importantly, signs are opposite to expectations in the two cases where coefficients are highly significant (for *fixed assets ratio* and *Loss given default*). This result further corroborates the conclusion that ex-post inefficiency is more relevant than ex-ante efficiency in choosing optimal debt structure complexity.

1.5 Conclusion

This paper provides the first attempt to document empirically whether concerns about strategic debt service affect the firm's choice between public an private debt. Controlling for other determinants of creditor dispersion, this study tests whether firms which are particularly prone to opportunistic behavior make increased use of public debt. Incentives for strategic behavior are measured by different proxies for asset tangibility and, alternatively, by the percentage by which debt exceeds tangible assets.

The results indicate that strategic considerations do not play a dominant role in the decision to issue public debt. Although statistical significance is in general weak, the overall evidence suggests that, contrary to the prediction, firms tend to rely *less* on public debt when the threat of strategic default is more severe. This finding suggests that ex-post efficiency is more important than ex-ante efficiency for the optimal degree of creditor dispersion. It is also consistent with the view that concentrated debt holders are generally more effective than a dispersed ones in controlling moral hazard problems within a corporation, strategic default being one of them.

One concern with the analysis is that it makes the extreme assumption that public debt is highly dispersed while private debt is concentrated. In reality, a public debt issue may be held by only a few investors and private debt may be provided by multiple banks. Ideally, one would measure creditor dispersion by the exact number of claim holders, bond holders plus lending banks and other private investors. Unfortunately such data is not available. However, in defense of the approach taken in this paper one may argue that, by issuing public debt, the firm signals its willingness to disperse its creditor structure. Once public debt is issued, the actual degree of dispersion is no longer under the firm's control and can potentially be highly dispersed.

Another concern is that Hypotheses 1 and 2 are based on the assumption that highly dispersed public debt creates renegotiation frictions that lead to coordination failure in default. In formal bankruptcy, however, public debt often becomes more coordinated through the appointment of a creditor committee. The fact that, in reality, public debt may be more coordinated than assumed, is another possible explanation for the lack of evidence for strategic concerns.

Finally, creditor dispersion is only one means to limit incentives for strategic behavior. Priority and maturity are characteristics of debt that can be chosen so as to shift the balance of bargaining power toward creditors. These may simply be more effective or less costly means to deter strategic threats, thereby making creditor dispersion less relevant as a commitment device against opportunistic behavior.

Chapter 2

Asset Substitution: An Empirical Analysis

2.1 Introduction

The analogy between a levered firm's equity and a call option was first noted in the seminal work by Black and Scholes (1973). According to this view, the presence of defaultable debt in a firm's capital structure may induce shareholders to increase risk at the expense of debtholders. This agency conflict is typically referred to as the asset substitution or risk shifting problem. Since its first reference in Jensen and Meckling (1976) a large, mostly theoretical literature has examined the impact of the asset substitution problem on firms' financing and investment decisions. However, despite the intensive debate, no consensus has been reached to date as to the actual relevance and magnitude of the problem. This may be due to the fact that prior empirical research, by examining whether agency problems are reflected in capital structure, has so far mainly provided *indirect* support for the asset substitution hypothesis.

Two aspects complicate inference on the asset substitution conflict. The first regards the econometric difficulty associated with documenting the *causal* effect of leverage on firms' risk policy. This is due to the apparent endogeneity of leverage in the leverage-risk relation. Our knowledge of what determines optimal operational risk is far from complete, and the empirical literature has so far provided only mixed evidence on the determinants of risk policy. It is therefore likely that there exist unknown or unobservable factors which simultaneously affect firms' financing and risk policy, as leverage and risk are closely related. Failure to account for these unobservable factors will produce biased coefficients in a reduced form regression of risk on leverage. In addition, there is a causality issue in the leverage-risk relation. Tradeoff models of capital structure building on the Modigliani and Miller (1958, 1963) assumptions typically assume the firm's underlying asset risk to be exogenous while leverage is endogenously determined. Since asset risk increases expected bankruptcy costs, this framework predicts a *negative*, causal effect of asset risk on leverage. The agency view, on the other hand, predicts a *positive*, causal effect of leverage on asset risk.

The second difficulty is the measurement of asset volatility. Except for purely equity-financed firms, asset volatility is unobserved. Therefore, in the past, most studies have used rough measures of firm risk, such as company size or R&D expenditures. Others have employed equity volatility which includes both operating and financial risk.

The present paper addresses both of these concerns. The measurement problem is addressed by inferring asset volatility from equity prices using contingent claim firm value models. In estimating implied volatilities, I follow recent work by Vassalou and Xing (2004), Fang and Zhong (2004) and Larsen (2006). The endogeneity concerns are addressed by employing instrumental variables methods which exploit exogenous sources of variation in leverage.

The results indicate that a causal effect of leverage on asset volatility exists. However, this effect is statistically and economically significant only for long-term leverage, that is, when leverage is defined as the ratio of long-term debt to total assets or market value. An increase in long-term leverage of 10 percentage points results, on average, in an increase in asset volatility of between 3.4 and 6.9 percentage points. The coefficients of total leverage, on the other hand, are statistically insignificant at conventional levels. This is consistent with the predictions of theoretical models such as Leland and Toft (1998), which argue that short-term debt significantly reduces risk-shifting incentives.

Further results show that risk-taking incentives as provided by executive compensation, in particular through executive stock options, aggravate the asset substitution problem. CEOs whose fraction of option value in total compensation is above median show a substantially higher sensitivity of asset risk with respect to long-term leverage than their below median counterparts. In fact, for CEOs receiving high-powered incentives, the sensitivity of asset volatility to leverage is statistically significant even for total leverage, not only for long-term leverage. This is an interesting finding in that it indicates a tradeoff between two fundamental agency conflicts: By improving shareholder-manager alignment incentive compensation seems to exacerbate the shareholder-bondholder conflict regarding the choice of asset risk.

In addition, I provide evidence that asset composition appears to be important for risk shifting. Firms with low proportions of fixed assets, short asset maturity and large amounts of liquid assets, are more prone to asset substitution. This reflects the fact that actual risk policy depends not only on *incentives* but also on the *ability* to shift risk. A company which operates primarily long-lived, fixed assets may simply not be able to shift operational risk in response to capital structure changes as easily a company which owns mostly short-lived or liquid assets.

Finally, my results suggests that ownership concentration mitigates leverage-induced risk-taking. This may, at first sight, appear counterintuitive as ownership concentration should motivate or force managers to act in shareholders' interests. However, blockholders with large stakes in a particular firm are likely to be highly underdiversified and hence may prefer lower risk levels than diversified investors, in particular when leverage is high.

This paper extends the limited literature which tries to provide direct evidence on the asset substitution hypothesis. Brown et al. (1996), Chevalier and Ellison (1997), and Brown et al. (2001) show that risk shifting can be observed in the mutual and hedge fund industries where fund managers have option-like compensation schemes. Recent work by Fang and Zhong (2004) and Larsen (2006) examines risk shifting for U.S. industrial firms using implied volatilities. These studies do not, however, account for endogeneity which is the main motivation for the empirical setup in this paper. Further, they do not provide evidence of the role of shareholder-manager alignment and ownership concentration, nor on the role of asset tangibility in the context of asset substitution.

The rest of the paper is organized as follows. Section 2.2 lays out the empirical framework and details how the endogeneity issue is addressed. Section 2.3 describes the models and estimation method used to infer asset volatility. Section 2.4 describes the data. Section 2.5 presents the main results while sections 2.7 and 2.6 analyze asset composition, executive compensation and ownership concentration in the context of asset substitution. Section 2.8 concludes.

2.2 Empirical Framework

2.2.1 The Leverage-Risk Relation

The main problem with identifying the causal effect of leverage on firms' operational risk is the endogenous nature of leverage. The theoretical and empirical literature modeling leverage as a choice variable is among the most extensive ones in corporate finance. However, the mere fact that leverage is chosen by shareholders or management would not, per se, create an endogeneity problem in the statistical sense if all determinants of leverage and risk were observable. In that case, a regression of asset risk on leverage and all joint determinants of leverage and risk would produce a consistent estimate of leverage's effect on risk policy.

The endogeneity problem arises from the fact that unobservable or unknown factors are likely to be important determinants of both leverage and firm risk. This is particularly apparent in the case of corporate risk policy. Even though there exists a large literature on hedging, the empirical evidence to date is far from being conclusive. For instance, examining the extent of corporate derivatives use, Guay and Kothari (2003) find the actual reduction in exposure due to hedging to be so small as to question the relevance of many theoretical and empirical findings on firms' derivatives use. In another recent study analyzing the determinants of corporate hedging policy in a large cross-country sample, Bartram et al. (2004) find evidence clearly counter to the most widely-cited theories. This suggests that our knowledge about what drives firms' risk profiles is still very limited, and it is reasonable to believe that unknown and unobservable factors play an important role in this context.

The second reason for endogeneity in the risk-leverage relation is that causality may run in both directions. The strand of literature building on the Modigliani and Miller (1958, 1963) assumptions that investment and financing decisions are independent, commonly assumes asset volatility to be an exogenous variable affecting optimal leverage. In classical tradeoff models of capital structure, higher asset volatility increases expected bankruptcy cost thus decreasing optimal leverage. Agency theory, on the other hand, argues that leverage has a causal effect on firms' risk policy. The asset substitution hypothesis states that leverage creates incentives to increase firm risk. It is likely, therefore, that both effects are at play at the same time. Since the two causal relations work in opposite directions, a reduced form regression will produce a downward biased coefficient for the effect of leverage on risk.

2.2.2 The Empirical Model

To account for the endogeneity in the leverage-risk relation I estimate the following empirical model:

$$\Delta\sigma_{it} = \alpha_1\sigma_{i,t-1} + \alpha_2\Delta LEV_{it} + \alpha_3\Delta X_{1it} + \alpha_4 Z_{1it} + \epsilon_{1it} \tag{2.1}$$

$$\Delta LEV_{it} = \beta_1 LEV_{i,t-1} + \beta_2\Delta X_{1it} + \beta_3 Z_{2it} + \epsilon_{2it} \tag{2.2}$$

Equation (2.1), the volatility equation, models changes in asset volatility as a function of lagged volatility, leverage changes, changes in common determinants, ΔX_{1it}, and instruments Z_{1it}. Equation (2.2) is the leverage equation. It relates changes in leverage to lagged leverage, changes in common determinants, ΔX_{1t}, and instruments Z_{2it}.

The estimation of equations (2.1) and (2.2) with two-stage least squares (2SLS) implements an estimator akin to the so-called "difference-GMM" estimator developed by Anderson and Hsiao (1982) and Arellano and Bond (1991). The motivation for the difference specification lies in the need to eliminate fixed effects in a dynamic panel model. The lagged dependent variables represent internal instruments which exploit the strong mean reversion of both volatility and leverage. In addition to these, I also employ external instruments. The use of external instruments is essential in this case as the endogeneity concerns do not only arise from the (time-invariant) fixed effect but also from time-varying shocks to both volatility and leverage that may be driven by a common unobservable variable.

To see how time-varying unobservables can affect the estimate of the coefficient of interest, α_2, assume that a shock in a common variable, Δu_t, affects both volatility and leverage. If the source of the shock is unobservable, its effect is captured in both error terms, ϵ_{1it} and ϵ_{2it}. Without accounting for this, the estimate of α_2 will be biased and inconsistent, because leverage changes are correlated with the error term in equation (2.1), $\mathrm{corr}(\Delta LEV_t, \epsilon_{1it}) \neq 0$. To illustrate this point, assume that an unobservable change in firm fundamentals increases business risk and simultaneously decreases optimal leverage. Then, a reduced form regression of the volatility equation will produce a downward biased estimate of the leverage coefficient.

As an external instrument for leverage changes I use the after-financing marginal tax rate as proposed by Graham (1996). Graham shows that the after-financing marginal tax rate is significantly correlated with *incremental* financing decisions. As an external instrument for volatility changes I use market-wide fluctuations in volatility.

The main results of this study are based on the specification of the system given by equations (2.1) and (2.2), which does not explicitly allow for reverse causation. However, in Section 2.5.2 I also present the estimation results for the following simultaneous equations model which explicitly accounts for the feedback of assets volatility on leverage:

$$\Delta\sigma_{it} = \alpha_1\sigma_{i,t-1} + \alpha_2\Delta LEV_{it} + \alpha_3\Delta X_{1it} + \alpha_4 Z_{1it} + \epsilon_{1it} \tag{2.3}$$

$$\Delta LEV_{it} = \beta_1 LEV_{i,t-1} + \beta_2\Delta\sigma_{it} + \beta_3\Delta X_{1it} + \beta_4 Z_{2it} + \epsilon_{2it} \tag{2.4}$$

The results for the simultaneous equations model are very similar to the ones obtained from the baseline model.

2.3 Estimating Asset Volatility

To infer firms' asset volatility I estimate an unlevered version of equity volatility. Traditionally, firms' fundamental risk has been measured using proxies such as industry class, research and development expenditures, variation in operating income or equity volatility. While equity volatility contains both operating and financial risk, all other proxies share the feature that they use very few observations. Operating income data, for instance, is at best available at a quarterly frequency. A main advantage of inferring asset volatilities from equity prices is the availability of high frequency data which potentially yields much more accurate estimates.

Asset volatility is, in general, not observed except for purely equity financed firms. A model that relates asset volatility with equity volatility and leverage is therefore needed to recover asset volatilities from stock prices. There exist a host of different contingent-claim models of firm value, so that the issue of robustness to model choice naturally arises. To reduce robustness concerns with respect to model structure and assumptions, I employ a range of structural firm value models which are described briefly below.

2.3.1 The Models

I use the structural models of Black&Scholes (1973), Leland (1994) and Leland&Toft (1996) to calculate implied asset volatilities from stock prices. For brevity of exposition I discuss only the main features of the models in the main body of the paper. The specific formulas are relegated to the appendix.

Consider first the common characteristics of the three models. The fundamental variable in all models is the asset value (the value of the unlevered firm) which is assumed to follow a geometric Brownian motion under the risk-neutral probability measure:

$$dV_t = V_t(r - \delta)dt + V_t \sigma_V dW_t, \tag{2.5}$$

where V_t is the asset value, r is the risk-free interest rate, δ is the payout rate, and σ_V is the volatility of the asset value. W is a standard Brownian motion.

The firm's capital structure consists of two classes of securities, equity and debt. Denote by E_t the market value of equity and by D_t the market value of the firm's debt. Firm value is the sum of the market values of equity and debt.

In all three models, equity is viewed as a call option on a firm's assets. This implies a common relation between equity volatility, leverage and asset volatility. Applying Îto's lemma to the equity value, one obtains

$$\sigma_E = \sigma_V \, \frac{\partial E/E}{\partial V/V}, \tag{2.6}$$

where the elasticity of the equity value with respect to the asset value, $\epsilon_{E,V} = \frac{\partial E/E}{\partial V/V}$, is always greater than one. The extent to which equity volatility is scaled down to asset volatility depends on the specific model and parameter choice. The main determinants of the elasticity are discussed in detail in section 2.4.2 below along with the estimation results.

The main differences between the three models are the following: First, the models differ in their specification of default. In Black&Scholes default can occur only at maturity. Equity is thus equivalent to a European call option. In the Leland and Leland&Toft models default occurs when the asset value hits an endogenous default barrier, V_B, which can happen any time in the interval [0,T]. In these models equity is analogous to a down-an-out barrier option.

Second, in Black&Scholes, the firm value is equal to the value of the assets while the Leland and Leland&Toft models incorporate tax benefits and bankruptcy cost. Coupon payments are tax-deductable at rate τ and favor the use of debt while a fraction α of the asset value is lost in case of bankruptcy which counterbalances the tax advantages of debt. Firm value in the latter models is thus the sum of the asset value, tax benefits, and bankruptcy costs.

A third difference regards the assumptions about debt maturity. In Black&Scholes, there is a single, homogenous class of debt which is repayable at maturity T. The Leland model assumes perpetual debt which promises a continuous coupon rate C. In Leland&Toft, new debt is issued and old debt is repayed continuously. While the maturity at issuance is the same for all issues, the firm has a continuum of debt issues outstanding with maturities spanning the entire interval [0,T].

In sum, the three models contain a number of features, the Leland&Toft model being the richest and probably the most realistic one among them. Other models that could potentially be considered are those that allow for deviations from absolute priority (or strategic default), models incorporating multiple classes of debt with respect to seniority and protective covenants. While estimation of asset volatilities is, in principle, feasible for the latter models, the correlation of implied volatilities across the different models is likely to be fairly high due to the common contingent claim setup. Section 2.4.2 shows that the correlations among asset volatilities implied by the Black&Scholes, Leland, and Leland&Toft models are above 95%.

2.3.2 Implementation

To estimate asset volatilities I use the KMV algorithm, an iterative procedure proposed by Crosbie and Bohn (2003) which has become increasingly popular in academic work recently. Traditionally, asset volatilities have been estimated by solving a system of simultaneous equations given by the formula for the equity value and equation (2.6) for the two unobserved variables asset volatility and asset value. However there is no proof of consistency of the simultaneous equations approach. On the other hand, recent theoretical work demonstrates consistency of the KMV method for estimating asset volatilities, showing the equivalence of the KMV and maximum likelihood methods (Duan et al., 2004).

I follow Vassalou and Xing (2004), Fang and Zhong (2004), and Larsen (2006) in adapting the KMV algorithm to the respective models of Black&Scholes, Leland and Leland&Toft. To start the algorithm I use equity volatility as an initial guess for asset volatility. In a second step, the endogenous default barrier is calculated based on the initial volatility estimate for the Leland and Leland&Toft models. Note that this is not necessary for the Black&Scholes model. Next, asset values are computed for each day over the estimation window by inverting the respective pricing formula for equity. The obtained time series of asset values is then used to update the estimate of asset volatility. This procedure is repeated until σ_A converges. The tolerance level for convergence is set to $10e^{-5}$.

To implement the estimation procedure, a number of input parameters are need to be specified. In the following I discuss the specification of these inputs which are summarized in Table 2.1. All three models require values for the debt principal, P, the equity value, the risk-free rate, r, the payout rate, δ, the default threshold, V_B, and debt maturity, T. I set the principal amount, P, to Compustat's total debt. Equity value for a given day is calculated as the number of shares outstanding multiplied by the closing price. The risk-free interest rate is set to the 1-year constant maturity Treasury bill rate obtained from the Federal Reserve. The payout rate is set to 0.06, which according to Huang and Huang (2003) reflects the historical average payout rate for a large sample of U.S. firms. The default threshold is set to total debt for the Black&Scholes model, while it is endogenously determined in the Leland and Leland&Toft models. For the Black&Scholes and Leland&Toft models I follow Larsen (2006) in calculating debt maturity as the weighted average maturity using Compustat data on debt due within the first to fifth year and long-term debt. Consistent with Larsen (2006), the maturity of debt due after the fifth year is set to 8.5 years. The Leland model needs no specification of maturity as debt is assumed to be infinitely lived.

The Black&Scholes model requires the dividend rate as an additional input. This is calculated as $\log(1 + \text{Dividends}/(E + P))$, where E is the equity value at fiscal year end. The Leland and Leland&Toft models also require inputs for the corporate tax rate, τ, the proportional bankruptcy costs, α, and the total coupon, C. I set $\tau = 20\%$ and $\alpha = 15\%$. The coupon is calculated as $(r + \text{spread}(T)) \cdot P$ where spread is set to the average yield spread on corporate bonds in the industrial sector as estimated by Duffee (1998) in the respective maturity bracket.

Table 2.1: Parameter definitions.

		Assigned Value		
Parameter	Notation	Black/Scholes/Merton	Leland	Leland/Toft
Equity value	E	$P_t \cdot N_t$	$P_t \cdot N_t$	$P_t \cdot N_t$
Debt Principal	P	Total debt	Total Debt	Total Debt
Debt Maturity	T	Weighted average	-	Weighted average
Debt Coupon	C	-	$(r + \text{spread(T)}) \cdot P$	$(r + \text{spread(T)}) \cdot P$
Risk-free rate	r	1-year T-bill rate	1-year T-bill rate	1-year T-bill rate
Default barrier	V_B	P	endogenous	endogenous
Tax rate	τ	-	20%	20%
Bankruptcy costs	α	-	15%	15%
Dividend rate	γ	$\log(1 + \frac{\text{Dividends}}{E+P})$	-	-
Payout rate	δ	0.06	0.06	0.06

2.4 Data

2.4.1 Sample Selection

The analysis is based on a large sample of panel data. The accounting data are taken from Compustat's U.S. research and active files over the period 1987 to 2003. Firms in the public and private transportation, communications and utility sectors (SIC codes 4000-4999), the financial sector (SIC 6000-6999), and government-related corporations (SIC 9100-9999) are deleted to avoid any issues with regulation, since risk shifting is less likely to be observable in firms where the discretion of management is constrained by regulation. I further restrict the sample to exclude firm years with a minimum book value of assets below \$10 million (inflation adjusted to 2000 dollars), and those firm years with missing data on total assets, net sales, debt in current liabilities, long-term debt, market value of equity, operating income before depreciation, and net property, plant and equipment. The remaining sample is merged with daily stock price data from Datastream. Of the resulting sample I retain firm years for which price data is available for at least 100 trading days in a given fiscal year. Finally, I exclude 24 firm years where book leverage is greater than one.[1] In unreported analysis I find that the results are robust to the inclusion of these firm years. Finally, I intersect my original data with Graham's (1996) marginal tax rates data. Depending on the asset volatility measure employed, the final sample for the baseline instrumental variables regressions contains between 19,226 and 19,731 observations.

2.4.2 Asset Volatilities: Summary Statistics

Table 2.2 displays descriptive statistics of the estimated annualized asset volatilities along with the endogenous default thresholds for the Leland and Leland&Toft models. The rows in the upper part of the table contain the medians of the respective estimates for the entire sample of firms, year by year, over the sample period from 1987 to 2003. Column 1 contains equity volatility. Columns 2 to 4 report the asset volatility estimates as implied by the three models. The time-series of median volatilities is graphically illustrated in Figure 2.1. In addition, the lower solid line in the figure plots the volatilities of an equal-weighted portfolio comprised of all stocks in the sample.

Column 1 contains the equity volatilities. The high level of volatility at the beginning of the sample period is primarily due to the stock market crash in October 1987 which caused daily returns of the equal-weighted portfolio of up to -14%. Following the recovery in 1988 and 1989, equity volatilities were strongly upward trending until 2000, again followed by a sharp decline during the last years of the sample period. Interestingly, the time-series of portfolio volatilities (bottom solid line in Figure 2.1) shows no similar pattern. This indicates that the upward trend in individual firms' total volatility is mainly due to an increase in idiosyncratic volatility, a fact that has been also documented by Campbell et al. (2001) and Goyal and Santa-Clara (2003).

The overall level of equity volatility may appear high at first sight, but is consistent with other studies on total volatility. Using the entire CRSP database over the period 1962-1999 Goyal and Santa-Clara (2003) obtain an average annualized volatility of individual stocks of 56.81% ($\sqrt{12} \cdot 0.1640$), with higher values towards the end of their sample period. This

[1] Although it would be interesting to study the risk behavior of firms close to default, the concern with overindebted companies is that they may actually be in default so that management's discretion over investment policy is likely to be constrained.

compares to the 62.43% volatility averaged over all firms and years in my sample. They also find that average individual stock volatility is more than four times higher than the volatility of an equal-weighted portfolio constructed from the same stocks. This relation, again, is in line with the average portfolio volatility of 12.95% in my sample.

Columns 2 to 4 contain the asset volatility estimates for the Black&Scholes, Leland, and Leland&Toft models. As implied by the model, structure all asset volatilities are smaller than the equity volatilities. By how much equity volatility is scaled down to asset volatility depends on the model structure and parameter specification which determine the elasticity of equity with respect to the asset value, $\epsilon_{E,A}$. Even though there are a large number of parameters that affect the size of the elasticity, and comparative statics are somewhat complex, two factors are of particular importance: default barrier and debt maturity.

To understand the direction of the effects, assume for simplicity that the default barrier is fixed exogenously. Then a higher default barrier implies a larger elasticity, $\epsilon_{E,A}$, and thus a smaller asset volatility for a given equity volatility. Intuitively, this is because, with a high barrier, an increase in asset value not only increases the expected value of the payoff at maturity, but it also lowers the probability of early default. This explains why barrier models typically imply lower asset volatilities than the Black&Scholes model.

The second main factor, maturity, affects the scaling of equity volatility via two channels. First, shorter maturity increases the endogenous default threshold thus decreasing $\epsilon_{E,A}$, but, in addition, has a separate effect increasing $\epsilon_{E,A}$. In contrast to Black&Scholes, the Leland model has a strictly positive default threshold which *increases* $\epsilon_{E,A}$ while, on the other hand, it assumes infinite maturity which *decreases* $\epsilon_{E,A}$. This is the reason why asset volatilities implied by the Leland model are not always smaller or larger than those implied by the Black&Scholes model as can be seen in columns 2 and 3 of Table 2.2 and Figure 2.1. The Leland&Toft model, which has both a default barrier and finite maturity, generates asset volatilities which are strictly lower than those implied by both the Black&Scholes and the Leland models.

Columns 5 to 7 display the respective default thresholds of the three models. By definition, the barrier of the Black&Scholes model is zero, while the Leland&Toft model generally implies higher barriers than the Leland model, especially for intermediate and short maturities. This is because the need to redeem debt places a much higher burden on firm's cash flows.

Table 2.2: Asset volatilities and default barriers. The table presents summary statistics of the asset volatility and default barrier estimates obtained from the Black&Scholes, Leland, and Leland&Toft models. Columns 1 to 4 in the upper part of the table contain the medians of the volatility estimates by year. Columns 5 to 7 contain the estimates of the default barrier (which is zero by assumption for the Black&Scholes model). The lower part of the table displays summary statistics for the entire sample period.

		ASSET VOLATILITIES			DEFAULT THRESHOLDS			
Year	σ^E	σ^{BS}	σ^L	σ^{LT}	V_B^{BS}	V_B^L	V_B^{LT}	N
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1987	0.5351	0.4104	0.3973	0.3712	0.0000	0.4444	0.6486	923
1988	0.4692	0.3330	0.3114	0.2997	0.0000	0.5454	0.7131	958
1989	0.3978	0.2800	0.2731	0.2648	0.0000	0.5862	0.7475	1,041
1990	0.5074	0.3578	0.3441	0.3224	0.0000	0.4974	0.7153	1,090
1991	0.5410	0.3777	0.3745	0.3476	0.0000	0.4447	0.6923	1,200
1992	0.5447	0.4087	0.4058	0.3730	0.0000	0.3913	0.6697	1,346
1993	0.5267	0.4275	0.4254	0.3903	0.0000	0.3606	0.6685	1,519
1994	0.5132	0.4062	0.4097	0.3835	0.0000	0.4216	0.6723	1,677
1995	0.5027	0.4049	0.4131	0.3847	0.0000	0.3706	0.6709	1,831
1996	0.5367	0.4495	0.4508	0.4272	0.0000	0.3527	0.6494	2,001
1997	0.5222	0.4362	0.4389	0.4150	0.0000	0.3449	0.6477	2,100
1998	0.5974	0.4845	0.4941	0.4505	0.0000	0.2727	0.6015	2,130
1999	0.6406	0.5288	0.5276	0.4838	0.0000	0.2930	0.6050	2,118
2000	0.7400	0.5884	0.5983	0.5342	0.0000	0.2342	0.5732	2,128
2001	0.6512	0.5141	0.5272	0.4707	0.0000	0.2662	0.6074	2,120
2002	0.5931	0.4702	0.4809	0.4425	0.0000	0.2586	0.6087	2,089
2003	0.4611	0.3665	0.3727	0.3479	0.0000	0.3408	0.6697	1,707
Mean	0.6371	0.5206	0.5209	0.4827	0.0000	0.3744	0.6232	-
Median	0.5557	0.4399	0.4411	0.4084	0.0000	0.3423	0.6451	-
Std	0.3617	0.3475	0.3502	0.3242	0.0000	0.2201	0.1880	-
5% Quantile	0.2328	0.1349	0.1237	0.1094	0.0000	0.0755	0.2839	-
95% Quantile	1.3397	1.1889	1.2025	1.1086	0.0000	0.7815	0.8911	-

2.4.3 Measures of Leverage

I measure the firm's capital structure using a range of leverage specifications. For the base case I use two market-based measures of leverage. The first is simply market leverage, *LEV-MV*, defined as the sum of long-term debt and debt in current liabilities, divided by the firm's market value. The second is long-term market leverage, *LEV-LT-MV*, defined as long-term debt divided by market value. Market leverage is the specification which best reflects the spirit of contingent claims models as default risk is a function of the distance between the market value of assets and the default threshold. The use of long-term leverage has the additional advantage of allowing an analysis of the impact of debt

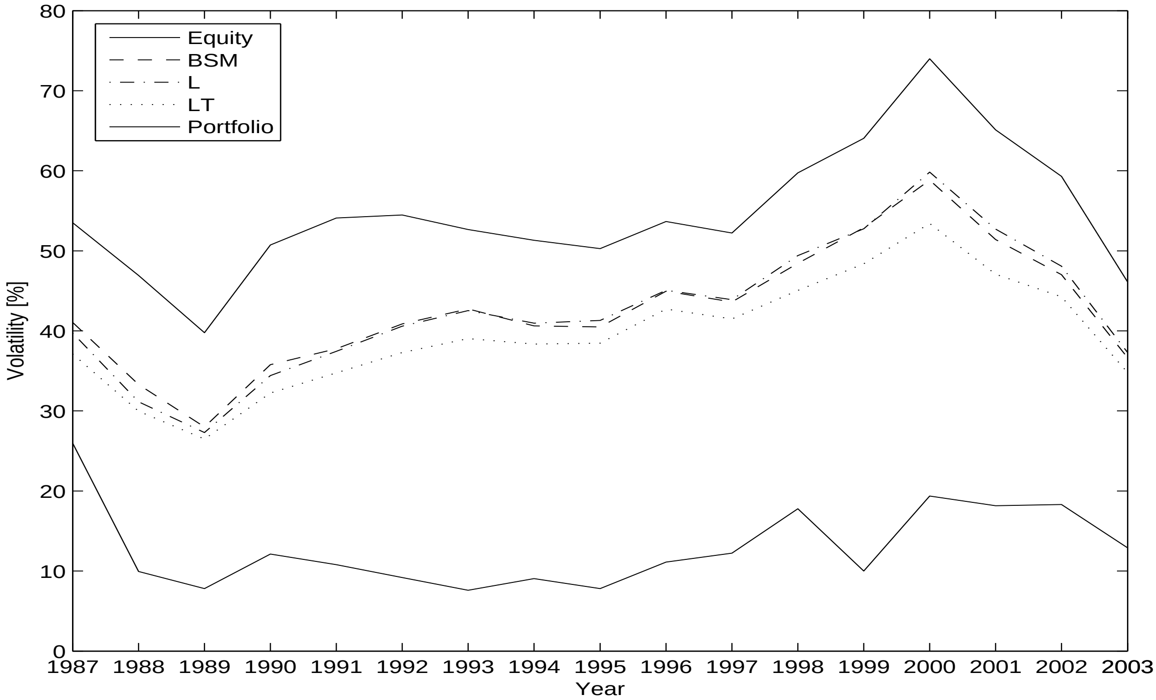

Figure 2.1: Time-series of volatilities. The upper four lines of the figure plot the median of the respective volatility estimates by year, as shown in Table 2.2. The lower solid line plots the volatility of an equal-weighted portfolio of the stocks in the sample.

maturity structure on asset substitution. Many models, including Leland&Toft, predict more pronounced risk shifting incentives when debt is long-term rather than short-term.

For additional robustness I also use book-based measures of leverage, *LEV-BV* and *LEV-LT-BV*, defined as the sum of long-term debt and debt in current liabilities, divided by the book value of assets, and long-term debt divided by the book value of assets, respectively. This specification has the advantage of being less dependent on stock price fluctuations and may more adequately reflect a firm's target capital structure. In addition, employing book leverage avoids a subtle causation mechanism which can bias the inference on the agency motive: Suppose the stock price drops sharply due to some exogenous shock to firm prospects. For a levered firm, this will imply an increase in market leverage (but not book leverage) and equity volatility. Some of that increase in volatility may seep into asset volatility and hence give the impression of asset substitution even if management takes no action to increase risk.[2]

[2] I thank René Stulz for pointing this out to me.

2.4.4 Instruments

The main challenge in accounting for endogeneity in the proposed empirical framework is to identify valid instruments. In the case of the leverage-risk relation this is particularly intricate for two reasons: First, there is no established empirical literature on the firm-specific factors driving optimal operational risk. Second, leverage and risk are so closely related that it is difficult to find variables that significantly affect leverage but not asset volatility or vice versa. For instance, if one considers the most established determinants of leverage, such as size, market-to-book, profitability, and tangible assets, one can easily argue that they also affect asset risk. Larger firms are usually more diversified. Firms with high market valuations possess more (risky) growth options. More profitable businesses are, on average, more mature and hence less risky. And finally, tangible assets generate more stable cash flows than intangibles.

The autoregressive nature of both leverage and volatility suggests the use of lagged levels as instruments for changes in these variables. As shown in Table 2.3, lagged leverage (lagged asset volatility) is highly negatively correlated with the change in leverage (asset volatility). This indicates strong mean reversion in both variables, a fact that makes lagged levels well-suited as instruments.

For the leverage equation I use a second, external instrument in addition to lagged leverage: the after-financing marginal tax rate, MTR. Graham (1996) demonstrates that a simulated version of the after financing tax rate is positively related with incremental financing decisions. The univariate correlation of the marginal tax rate with leverage changes does not appear very high (0.07), but it is much higher than its correlation with risk changes (-0.01). Further, as will be shown in Section 2.5, due to the inverse relation between leverage and the after-financing marginal tax rate, the latter becomes highly significant in a multivariate regression once leverage is controlled for.

I also identify a second instrument for the volatility equation, the market-wide change in asset volatility, $\Delta\sigma^{MKT}$. It is defined as the change in the median asset volatility over all firms in the sample. Using market-wide volatility changes in the regression specification is important not only because it provides a good instrument, but also because it controls for volatility changes that may be due to market sentiment or other factors unrelated to operational risk changes. Figure 2.1 shows that the stock market crash of 1987 and the dot-com bubble in the late 1990s caused high volatility in equity markets. By virtue of the estimation setup, any non-fundamental changes in equity volatility will be reflected in asset volatilities and should thus be controlled for.

The univariate correlations with firm-specific volatility changes are high (between 0.28 and 0.30) while its correlation with leverage changes is relatively low (0.09). I use asset volatilities implied by the Leland model to compute market-wide median volatilities. Due to the high correlations of $\Delta\sigma^{BS}$, $\Delta\sigma^{L}$, and $\Delta\sigma^{LT}$ results are unchanged when using any of the other models.

Table 2.3: Correlations. The table displays Spearman correlations between the main variables of interest.

	LEV-MV	Δ*LEV-MV*	σ^{BS}	σ^{L}	σ^{LT}	$\Delta\sigma^{BS}$	$\Delta\sigma^{L}$	$\Delta\sigma^{LT}$	$\Delta\sigma^{MKT}$	*MTR*
LEV-MV	1.00									
Δ*LEV-MV*	-0.20	1.00								
σ^{BS}	-0.36	0.06	1.00							
σ^{L}	-0.37	0.06	0.98	1.00						
σ^{LT}	-0.45	0.08	0.97	0.98	1.00					
$\Delta\sigma^{BS}$	0.05	-0.07	-0.25	-0.23	-0.23	1.00				
$\Delta\sigma^{L}$	0.06	-0.06	-0.24	-0.24	-0.23	0.96	1.00			
$\Delta\sigma^{LT}$	0.06	-0.15	-0.25	-0.25	-0.25	0.96	0.97	1.00		
$\Delta\sigma^{MKT}$	-0.01	0.09	-0.09	-0.09	-0.07	0.29	0.30	0.28	1.00	
MTR	-0.10	0.07	-0.32	-0.31	-0.29	-0.01	-0.01	-0.01	-0.03	1.00

2.4.5 Common Explanatory Variables

Due to the close relation between leverage and risk, a number of variables are likely to affect both leverage and risk. My first control is the change in firm size, Δ*SIZE*, defined as the change in log sales. Larger firms are usually more diversified and less concentrated geographically than small firms. This makes them less risky and, in turn, reduces the cost of capital allowing them to take a higher debt load. In addition, they often have better access to public debt markets which also increases their debt capacity.

As a second control I use the change in the market-to-book ratio, ΔMTB, to proxy for growth opportunities. Growth opportunities should be negatively related to asset risk, because the option-like nature of these assets makes them more risky than tangible assets. Their uncertain nature should also support less debt in the firm's capital structure. In addition, firms with many growth options may borrow less, because this could induce them to follow suboptimal investment strategies in the sense of the underinvestment problem formalized by Myers (1977).

As a third control I use the change in profitability, $\Delta PROFIT$. *PROFIT* is defined as operating income before depreciation, divided by sales. Profitability is frequently argued to be negatively related with leverage because of a pecking order of financing (Myers, 1984). Due to the costs of external financing, internal funds are thought to be the preferred source of funds used to finance investments. Therefore, highly profitable firms need to resort less to external financing and thus have lower debt ratios. Profitability may, on the other hand, also be related to firm risk. Young, risky firms typically have negative or relatively low profits while they become profitable as they mature and risk declines.

My fourth control is the change in tangible assets, ΔPPE. Tangible assets are defined as the ratio of or property, plant, and equipment to total assets. Tangible assets should be negatively correlated with firm risk, because they typically generate more stable cash flows than intangible capital. They are positively related with leverage since, in addition to their lower riskiness, they provide collateral which increases borrowing capacity.

All variables which are ratios, i.e. *MTB*, *PROFIT*, and *PPE*, are winsorized at the one percent level to reduce outlier problems.

Finally, I use a rating dummy, *RATED*, as a control. Being rated implies access to public debt markets and thus allows firms to increase their debt levels more easily than unrated firms. On the other hand, the rating is likely related to changes in operational risk. Executives care a lot about their companies' rating (see, for instance, Graham and Harvey (2001)) and should, on average, be reluctant to implement operational strategies that would lower their rating. The rating dummy takes the value of one if the firm has a non-default rating by Standard&Poors, and zero otherwise.

2.5 Main Results

2.5.1 The Basic Instrumental Variables Regressions

Table 2.4 presents the first stage leverage regressions for the base case where leverage is defined in terms of market values. For each of the dependent variables I run four regressions: one without any instruments, one regression with only one of the respective instruments, and a fourth regression containing all instruments.

The instruments have the expected sign and are significant whether used alone or jointly. The magnitude of the coefficient of the marginal tax rate is similar to that obtained by Graham (1996). The second instrument, lagged leverage, is highly significant indicating strong mean reversion in leverage ratios. When both instruments are included in the regression, R^2 more than doubles (from 0.04 to 0.09 and from 0.03 to 0.09 in the *LEV-MV* and *LEV-LT-MV* regression, respectively). This shows that the instruments make a significant contribution to the leverage equation supporting their validity.

The common variables, $\Delta SIZE$, ΔMTB, $\Delta PROFIT$, and ΔPPE are all significant and have the expected sign. The rating dummy has the expected positive sign in all regressions where lagged levels of leverage is included. It has a negative sign in all other cases. A possible reason for this could be that rated firms are typically more highly levered than non-rated firms and thus have less need to further increase debt. When leverage is not controlled for, rating may not only proxy (positively) for the access to debt markets but also (negatively) for the need to increase debt.

Table 2.5 presents the results of the second stage regressions of asset volatility changes on leverage changes and control variables. Column 1 though 4 display regression results on total debt market leverage, ΔLEV-MV. Column 1 reports the reduced form OLS regression. The leverage coefficient is negative and highly significant in both cases, indicating that, on average, increases in leverage are associated with decreases in firm risk. Columns 2 to 4 present the results of the instrumental variables regressions estimated with 2SLS. The signs of the leverage coefficient are not robust across the three proxies for asset volatility. However, even though the leverage coefficients using implied volatilities from the Black&Scholes and Leland models are negative, they are not significant. When using the Leland&Toft implied volatility the sign is positive and significant. In sum, when using total debt leverage, results are mixed and it is not clear, whether risk shifting is important or not. However, the coefficients and t-statistics in the 2SLS regressions suggest that the instrumental variables approach controls for much of the endogeneity in the leverage-risk relation.

Columns 5 through 8 display the results for long-term market leverage, ΔLEV-LT-MV. Again, in the reduced form regression, the leverage coefficient is negative and highly significant. In the instrumental variables regressions, however, the leverage coefficient is positive, highly significant and robust across the models. This suggests that risk shifting is important especially when firms issue long-term debt. This result is consistent with the predictions of many theoretical models, including Leland and Toft (1998), which argue that the need to frequently roll-over seasoned debt or renegotiate credit terms limits risk shifting incentives.

From a statistical viewpoint, the Hausman test reported in the last two rows of Table 2.5 strongly confirms the relevance of the endogeneity issue present in the leverage-risk

Table 2.4: First Stage Leverage Regressions. The table shows the regression results for the first stage regression of leverage on the common independent variables Δ*SIZE*, Δ*MTB*, Δ*PROFIT*, Δ*PPE*, Δ*RATED*, and the instruments *LEV-MV*, *LEV-LT-MV* and *MTR*. *SIZE* is the log of total assets. *MTB* is the market-to-book ratio. *PROFIT* is operating income before depreciation, divided by sales. *PPE* is the ratio of or property, plant, and equipment to total assets. *RATED* is a dummy variable indicating whether the firm has an S&P rating. *LEV-MV* is total debt divided by the market value of the firm. *LEV-LT-MV* is long-term debt divided by the market value of the firm. *MTR* is the after-financing marginal tax rate. T-statistics are in parentheses.

Dependent Variable	Δ*LEV-MV*				Δ*LEV-LT-MV*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LEV-MV		-0.1147		-0.1088				
		(-36.97)		(-30.64)				
LEV-LT-MV						-0.1522		-0.1435
						(-45.03)		(-37.51)
MTR			0.0421	0.0232			0.0286	0.0131
			(11.10)	(6.17)			(7.93)	(3.73)
Δ*SIZE*	0.0159	0.0087	0.0098	0.0034	0.0153	0.0097	0.0119	0.0072
	(9.22)	(5.13)	(4.49)	(1.58)	(9.24)	(6.09)	(5.69)	(3.54)
Δ*MTB*	-0.0083	-0.0077	-0.0091	-0.0085	-0.0060	-0.0054	-0.0067	-0.0061
	(-27.15)	(-25.65)	(-24.42)	(-23.35)	(-20.51)	(-19.17)	(-18.68)	(-17.76)
Δ*PROFIT*	-0.0072	-0.0057	-0.0075	-0.0062	-0.0046	-0.0036	-0.0050	-0.0040
	(-8.52)	(-6.92)	(-7.31)	(-6.22)	(-5.62)	(-4.56)	(-4.86)	(-4.25)
Δ*PPE*	0.1685	0.1584	0.1614	0.1547	0.1313	0.1206	0.1372	0.1290
	(19.28)	(18.57)	(15.17)	(14.87)	(15.74)	(14.97)	(13.49)	(13.11)
RATED	-0.0048	0.0055	-0.0047	0.0052	-0.0035	0.0111	-0.0030	0.0104
	(-3.54)	(4.06)	(-3.23)	(3.55)	(-2.84)	(8.92)	(-2.23)	(7.75)
N	27,307	27,307	20,188	20,188	27,989	27,989	20,732	20,732
Instr. F-test		1,366.41	123.23	533.76		2,027.89	62.89	737.04
(P-value)		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)
R^2 adj.	0.04	0.09	0.05	0.09	0.03	0.09	0.03	0.09
Partial R^2		0.05	0.01	0.06		0.06	0.00	0.06

relation.

2.5.2 Robustness

Alternative Econometric Specifications. To gauge robustness of the results with respect to the econometric model, I also estimate the simultaneous equations specification given in equations (2.3) and (2.4). Panel A of Table 2.6 displays the leverage coefficients obtained from this econometric model estimated with three-stage least squares (3SLS), along with those obtained from a reduced form regression estimated with OLS, and the 2SLS estimates already reported in the previous section. Sign, significance, and magnitude of the 3SLS estimates are very similar to those obtained from the 2SLS estimation. Again, the results for long-term leverage are robust across the volatility measures while results for total debt are mixed.

Alternative Leverage Specifications. In the main regressions presented in Tables 2.4 and 2.5 I have used the two market-based measures of leverage, market leverage (*LEV-MV*) and long-term market leverage (*LEV-LT-MV*). Panel B of Table 2.6 also presents the leverage coefficients for two book-based leverage definitions: book leverage, *LEV-BK* and long-term book leverage, *LEV-LT-BK*. Even though book leverage does not appear as an explicit argument in contingent claims firm value models, it has the advantage of being more robust to market fluctuations in equity value, which could simultaneously affect leverage and volatility and hence lead to spurious results.

The results are qualitatively similar to those obtained with market leverage. In particular, the main result that the coefficient of long-term leverage, *LEV-LT-BK*, is positive and highly significant in the 2SLS and 3SLS regressions remains unchanged and the magnitude of the coefficient is comparable to the one obtained using market leverage. As for the base case regressions, the results for total book leverage, *LEV-BK*, are not robust across the three proxies for asset volatility.

2.6 Risk Shifting and Corporate Governance

To obtain the main results I have used a relatively parsimonious specification of the asset volatility equation. However, there likely exist other firm characteristics which influence risk shifting incentives provided by leverage. An obvious candidate is corporate governance, or more precisely, the alignment of shareholder and manager interests. Recall that risk

Table 2.5: Second Stage Asset Volatility Regressions. The table shows the results for the second stage regression of asset volatility on the predicted value of leverage changes and control variables. $\Delta SIZE$, ΔMTB, $\Delta PROFIT$, ΔPPE, $\Delta RATED$, and the instruments *LEV-MV*, *LEV-LT-MV* and *MTR*. *SIZE* is the log of total assets. *MTB* is the market-to-book ratio. *PROFIT* is operating income before depreciation, divided by sales. *PPE* is the ratio of or property, plant, and equipment to total assets. *RATED* is a dummy variable indicating whether the firm has an S&P rating. *LEV-MV* is total debt divided by the market value of the firm. *LEV-LT-MV* is long-term debt divided by the market value of the firm. $\sigma^{BS/L/LT}$ is lagged asset volatility estimated using the Black&Scholes, Leland or the Leland&Toft model, depending on the dependent variable used. σ^{MKT} is the average asset volatility over the entire sample in a given year. T-statistics are in parentheses.

	OLS	Instr. Variables Regressions			OLS	Instr. Variables Regressions		
Dept.Variable	$\Delta\sigma^L$	$\Delta\sigma^{BS}$	$\Delta\sigma^L$	$\Delta\sigma^{LT}$	$\Delta\sigma^L$	$\Delta\sigma^{BS}$	$\Delta\sigma^L$	$\Delta\sigma^{LT}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ*LEV-MV*	-0.2124	-0.1339	-0.1547	0.2434				
	(-14.79)	(-1.69)	(-2.11)	(3.27)				
Δ*LEV-LT-MV*					-0.1599	0.5485	0.3418	0.6971
					(-10.84)	(7.68)	(5.07)	(10.32)
$\sigma^{BS/L/LT}$	-0.1918	-0.2152	-0.1858	-0.1990	-0.1856	-0.2168	-0.1887	-0.2043
	(-49.70)	(-45.81)	(-42.29)	(-42.05)	(-48.93)	(-45.39)	(-42.32)	(-42.42)
$\Delta\sigma^{MKT}$	0.9183	0.8231	0.8420	0.7004	0.8914	0.7482	0.7787	0.6580
	(37.80)	(27.17)	(29.64)	(25.12)	(37.52)	(25.28)	(28.59)	(23.98)
$\Delta SIZE$	-0.0643	-0.0605	-0.0618	-0.0473	-0.0655	-0.0708	-0.0684	-0.0552
	(-15.71)	(-11.14)	(-12.05)	(-9.67)	(-16.22)	(-12.69)	(-13.18)	(-10.75)
ΔMTB	-0.0066	-0.0052	-0.0555	-0.0009	-0.0057	-0.0005	-0.0020	0.0014
	(-9.33)	(-4.61)	(-5.20)	(-0.87)	(-8.26)	(-0.51)	(-2.07)	(1.47)
$\Delta PROFIT$	0.0043	0.0033	0.0025	0.0049	0.0051	0.0078	0.0056	0.0069
	(2.20)	(1.29)	(1.04)	(2.14)	(2.63)	(3.02)	(2.37)	(2.97)
ΔPPE	0.0058	-0.0275	-0.0285	-0.1323	-0.0078	-0.1368	-0.1015	-0.1897
	(0.28)	(-0.95)	(-1.05)	(-5.00)	(-0.38)	(-4.60)	(-3.87)	(-7.27)
RATED	-0.0447	-0.0473	-0.0429	-0.0393	-0.0492	-0.0454	-0.0444	-0.0399
	(-13.73)	(-13.02)	(-12.45)	(-11.77)	(-15.72)	(-12.19)	(-13.12)	(-11.40)
N	25,743	19,589	19,731	19,226	26,465	19,589	20,272	19,226
R^2 adj.	0.15	0.16	0.15	0.09	0.15	0.11	0.10	0.07
Hausman test		63.35	60.52	126.11		88.50	113.48	219.77
(P-value)		(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)

Table 2.6: Robustness. The table reports estimates of the leverage coefficient for three different econometric models and four different leverage definitions. The first row in panels A and B contains OLS estimates of a reduced form regression of asset volatility on leverage and control variables. The second row contains estimates of the equation system (2.1) and (2.2) estimated with 2SLS. The last row shows the results for the simultaneous equation system (2.3) and (2.4) estimated with 3SLS. The results reported in Panel A are based on a market-based definition of leverage while those in panel B are based on a book-based definition. T-statistics are in parentheses.

PANEL A: MARKET-BASED LEVERAGE MEASURES

	LEV-MV			*LEV-LT-MV*		
	BS	L	LT	BS	L	LT
OLS	-0.1883	-0.2124	-0.3974	0.0925	-0.1599	-0.1934
	(12.34)	(-14.79)	(-30.18)	(5.84)	(-10.84)	(-13.91)
2SLS	-0.1339	-0.1547	0.2434	0.5485	0.3418	0.6971
	(-1.69)	(-2.11)	(3.27)	(7.68)	(5.07)	(10.32)
3SLS	-0.1420	-0.1655	0.1968	0.5412	0.3301	0.6731
	(-1.80)	(-2.26)	(2.65)	(7.58)	(4.91)	(10.02)

PANEL B: BOOK-BASED LEVERAGE MEASURES

	LEV-BV			*LEV-LT-BV*		
	BS	L	LT	BS	L	LT
OLS	-0.1725	-0.1829	-0.3157	0.0260	-0.1540	-0.1712
	(-13.92)	(-15.69)	(-29.57)	(2.04)	(-13.10)	(-15.43)
2SLS	0.0391	-0.0224	0.3251	0.5313	0.3332	0.5805
	(0.49)	(-0.30)	(4.17)	(8.26)	(5.55)	(9.61)
3SLS	0.0359	-0.0253	0.3090	0.5346	0.3367	0.5892
	(0.45)	(-0.34)	(3.97)	(8.32)	(5.62)	(9.79)

shifting is shareholder-debtholder conflict. In most public corporations, however, managers, not shareholders, take operational decisions. Since managers are typically regarded as more risk averse than shareholders, it is not obvious that the asset substitution conflict should be reflected in corporate investment decisions. Therefore, the alignment of interests between shareholders and managers should play an important role affecting the extent to which risk shifting occurs.

In this section I examine two means which are commonly thought to motivate managers to act in the interest of shareholders: executive compensation and ownership concentration.

2.6.1 Executive Compensation

In this section I focus on the risk-taking incentives provided to CEOs through their compensation schemes. Due to their high sensitivity to volatility, stock options arguable play the prevalent role in incentivizing managers to take higher risks.

I use the ExecuComp database to estimate CEOs' stock options portfolios following the procedure proposed by Core and Guay (2002). I compute three proxies for CEOs' risk-taking incentives provided through their compensation structure. My first measure is *COMPOUND VEGA*. *COMPOUND VEGA* is defined as the sensitivity of the CEO's stock and option portfolio with respect to asset volatility. Following the analogy of equity as a call option on assets, stock options represent a compound option on the assets - an option on another option. Computing *COMPOUND VEGA* thus involves the estimation of the derivative with respect to asset volatility of a compound option. To do this, I use the compound option model of Geske (1979). As a second proxy, I compute the sensitivity of CEOs' option portfolios with respect to equity volatility. I call this variable *BLACK-SCHOLES VEGA*. As a third proxy, I simply compute the ratio of the Black-Scholes value of options granted in a given year, divided by total compensation. I term this variable *OPTION COMPENSATION*.

Table 2.7 displays the results for the leverage coefficient of the second stage 2SLS base case regression. The first row in each panel reports the results for the entire sample with the required executive compensation data available. I split the sample in two subsamples based on the median with respect to the incentives measure used. The second row reports the leverage coefficients for the sample with above median compensation characteristics while the third row shows the analogous results for the complementary subsample. The coefficient estimates show that, for all incentive proxies, all leverage specifications and all asset volatility proxies, the leverage coefficient is higher in the subsamples where CEOs have above median risk-taking incentives. This suggests an important role for option compensation in the context of asset substitution.

2.6.2 Ownership Concentration

It it often argued that ownership concentration alleviates misalignment of managers' and shareholders interests. In firms which are owned by only a few investors, coordination of shareholder decisions is much easier, and managers that underperform can be fired more easily. Regarding risk policy, it is not obvious, however, if higher ownership concentration

Table 2.7: Risk shifting and executive compensation. The table presents 2SLS estimates of the leverage coefficient for different subsamples of the data. The first row of panels A and B contain estimates based on the entire sample for which the executive compensation characteristics are available. The second and third row contain estimates based on subsamples with above and below median values of the respective compensation characteristics. *COMPOUND VEGA* is the sensitivity of the CEO's firm-linked wealth with respect to asset volatility. *BLACK-SCHOLES VEGA* is the sensitivity with respect to equity volatility. *OPTION COMPENSATION* is the Black-Scholes value of CEO stock options as a fraction of total compensation. Panel A reports results based on a market-based definition of leverage while estimates in panel B are based on a book-based leverage definition. T-statistics are in parentheses.

PANEL A: LEV-MV

	COMPOUND VEGA			BLACK-SCHOLES VEGA			OPTION COMPENSATION		
	BS	L	LT	BS	L	LT	BS	L	LT
Entire Sample	0.3059	0.2593	0.4842	0.3059	0.2593	0.4842	0.3662	0.3360	0.5739
	(2.45)	(2.14)	(3.69)	(2.45)	(2.14)	(3.69)	(2.83)	(2.71)	(4.18)
Above Median	0.5574	0.6481	1.0550	0.9689	1.0325	1.5940	0.4586	0.5932	0.7845
	(3.12)	(3.53)	(4.69)	(4.00)	(4.14)	(4.53)	(2.43)	(3.15)	(3.79)
Below Median	0.1293	-0.0253	0.0796	-0.1052	-0.2002	-0.0280	0.3293	0.1426	0.4727
	(0.73)	(-0.15)	(0.46)	(-0.68)	(-1.36)	(-0.20)	(1.79)	(0.84)	(2.49)

PANEL B: LEV-LT-MV

	COMPOUND VEGA			BLACK-SCHOLES VEGA			OPTION COMPENSATION		
	BS	L	LT	BS	L	LT	BS	L	LT
Entire Sample	0.3826	0.3013	0.5281	0.3826	0.3013	0.5281	0.4511	0.3762	0.6248
	(3.15)	(2.68)	(4.23)	(3.15)	(2.68)	(4.23)	(3.57)	(3.26)	(4.77)
Above Median	0.6235	0.6357	1.0208	0.8888	0.8437	1.3851	0.6398	0.6584	0.9109
	(3.72)	(4.13)	(5.23)	(4.07)	(4.33)	(4.86)	(3.23)	(3.40)	(4.29)
Below Median	0.2026	-0.0383	0.1370	0.0496	-0.1332	0.0826	0.3369	0.1917	0.4707
	(1.16)	(-0.23)	(0.81)	(0.33)	(-0.95)	(0.59)	(1.99)	(1.33)	(2.79)

should lead to more pronounced asset substitution. The typical argument, that shareholders are diversified and therefore willing to take higher risks than undiversified managers, does not necessarily hold in corporations with large ownership concentration. Investors that own a sizable fraction of a company are usually not well-diversified, but instead have a large share of their wealth invested in a specific firm. Hence, risk aversion may play a role even on the ownership side.

To investigate whether ownership concentration leads to more or less asset substitution, I construct a proxy for ownership concentration from the data provided by Andrew Metrick which is described in detail in Dlugosz et al. (2005). *OWNERSHIP CONCENTRATION* is defined as the fraction of stock owned by all blockholders, where blockholders are investors with stakes that exceed 5% of a firm's equity.

Table 2.8 presents the leverage coefficients of the second stage base case regressions where, as above, results are reported for the entire sample, and above and below median sample splits. The results in the first row show that, in the entire sample with available ownership data, leverage coefficients are significantly positive, even for the total debt leverage measure. The above and below median subsample analysis indicates that risk shifting is actually less pronounced when ownership concentration is high. For both leverage measures and all volatility proxies, risk shifting is less pronounced for firms with above median ownership concentration. This suggests that capital protection rather than risk taking is the dominating motive in these firms.

Table 2.8: Risk Shifting and Ownership Concentration. The table presents 2SLS estimates of the leverage coefficient for different subsamples of the data. The first row contains estimates based on the entire sample for which the ownership concentration data is available. The second and third row contain estimates based on subsamples with above and below median values of the respective ownership concentration characteristics. *OWNERSHIP CONCENTRATION* is defined as the fraction of stock owned by all blockholders, where blockholders are investors with stakes exceeding 5% of a firm's equity. Underlying data are from Dlugosz et al. (2005). T-statistics are in parentheses.

	LEV-MV			*LEV-LT-MV*		
	BS	L	LT	BS	L	LT
Entire Sample	0.7017	0.7010	1.0909	0.7241	0.6832	1.0014
	(3.69)	(3.79)	(5.02)	(4.38)	(4.50)	(5.75)
Above Median	0.6190	0.6332	0.9095	0.7117	0.6901	0.9614
	(2.81)	(2.99)	(3.84)	(3.48)	(3.49)	(4.49)
Below Median	0.9868	0.9612	1.5914	0.8685	0.7843	1.1936
	(2.53)	(2.53)	(3.23)	(2.94)	(3.20)	(3.80)

2.7 Risk Shifting and Asset Structure

Besides the corporate governance structure which determines whether shareholders' incentives are translated into operational decisions, another important aspect is the *ability* to increase risk. Even if *incentives* exist, risk shifting may be constrained, for instance, due to the nature of the assets the company owns. It is arguable, for instance, that a corporation with a high proportion of fixed, long-lived assets, is unlikely to increase risk in short time in response to increased incentives provided by leverage. On the other hand, firms that hold large amounts of liquid assets, which are typically invested in capital markets, can more easily restructure their portfolios quickly. Taken literally, asset substitution should only be feasible if assets are substitutable.

Table 2.9 reports the base case second stage leverage coefficients for the entire sample and, in addition, two subsamples which are split at the median of three asset characteristics: asset maturity, the proportion if liquid assets to total assets, and tangible assets ratio.

The results strongly suggest that the composition of assets matters for risk shifting. In both leverage specifications (*LEV-MV* in panel A and *LEV-LT-MV* in panel B) risk shifting is more pronounced when assets have shorter maturities, when the proportion of liquid assets is high, and when the proportion of tangible assets is low.

2.8 Conclusion

This paper investigates whether leverage has a causal effect on corporate risk policy. The evidence suggests that, when the endogeneity of leverage is accounted for, a positive relation between leverage and asset volatility exists. However, this relation is statistically and economically significant only for long-term leverage, that is when leverage is defined as the ratio of long-term debt to total assets or market value. Consistent with theoretical predictions about the role of debt maturity for risk-shifting incentives (Leland and Toft, 1998; Ju and Ou-Yang, 2005), this implies that long-term debt aggravates while short-term debt curbs risk-shifting incentives.

Further evidence suggests that the risk-taking incentives provided to management through incentive compensation as well as the ability to shift operational risks, as determined by the nature of the assets, are important factors exacerbating the asset substitution problem.

A main insight of this study is that the causal effect of leverage on firm risk (as identified with instrumental variables regressions) is positive even though the partial correlation

Table 2.9: Risk Shifting and Asset Structure. The table presents 2SLS estimates of the leverage coefficient for different subsamples which differ in terms of the nature of their assets. The first row in each panel contains estimates based on the entire sample for which the respective asset characteristic is available. The second and third row contain estimates based on subsamples with above and below median values of the respective ownership concentration characteristics. *ASSET MATURITY* is the weighted maturity of the assets. *LIQUID ASSETS* is the proportion of cash and cash equivalents in the firms asset structure. *FIXED ASSETS* is the ratio of property, plant, and equipment to total assets. T-statistics are in parentheses.

PANEL A: LEV-MV

	ASSET MATURITY			LIQUID ASSETS			TANGIBLE ASSETS		
	BS	L	LT	BS	L	LT	BS	L	LT
Entire Sample	-0.1262	-0.1503	0.2485	-0.1548	-0.1726	0.2245	-0.1339	-0.1547	0.2434
	(-1.60)	(-2.05)	(3.34)	(-1.96)	(-2.36)	(3.03)	(-1.69)	(-2.11)	(3.27)
Above Median	-0.5399	-0.4366	-0.0075	0.1615	0.0114	0.2940	-0.5878	-0.4955	-0.0886
	(-5.16)	(-4.72)	(-0.08)	(1.18)	(0.08)	(2.24)	(-5.54)	(-5.22)	(-0.99)
Below Median	0.1226	-0.0256	0.4069	-0.5756	-0.4659	0.0136	0.2628	0.1015	0.5324
	(1.11)	(-0.25)	(3.74)	(-5.69)	(-5.35)	(-0.17)	(2.24)	(0.93)	(4.60)

PANEL B: LEV-LT-MV

	ASSET MATURITY			LIQUID ASSETS			TANGIBLE ASSETS		
	BS	L	LT	BS	L	LT	BS	L	LT
Entire Sample	0.5452	0.3389	0.6917	0.5321	0.3249	0.6798	0.5485	0.3418	0.6971
	(7.65)	(5.03)	(10.26)	(7.44)	(4.82)	(10.11)	(7.68)	(5.07)	(10.32)
Above Median	0.2088	0.0805	0.4557	0.7568	0.5140	0.8222	0.2175	0.0634	0.4236
	(2.41)	(1.04)	(5.94)	(5.40)	(3.72)	(5.81)	(2.41)	(0.77)	(5.33)
Below Median	0.6758	0.4266	0.7599	0.2649	0.1098	0.4261	0.7865	0.5228	0.8633
	(6.45)	(4.16)	(7.52)	(3.36)	(1.57)	(6.55)	(7.32)	(5.08)	(8.37)

between leverage and risk (as obtained from reduced form regressions) is negative. This suggests that asset risk generally decreases as firms take on higher levels of debt, but that this decrease is not as strong as it would be without the incentive effect of leverage. A practical implication of this finding is that creditors should anticipate the incentive effect of granting loans to their borrowers. Therefore, an interesting question left for future research is whether this incentive effect is priced in corporate bonds and loans.

Appendix 2.A The Models

2.A.1 The Black/Scholes/Merton Model

Equity value is given by

$$E(V) = Ve^{-dT}N(d_1) - e^{-rT}PN(d_2)$$

where

$$d_1 = \frac{ln(\frac{V}{P}) + (r - d + 0.5\sigma^2)T}{\sigma\sqrt{(T)}}$$

and

$$d_2 = d_1 - \sigma\sqrt{(T)}$$

2.A.2 The Leland Model

Firm value is given by

$$\begin{aligned} v(V) &= V + TB(V) - BC(V) \\ &= V + \frac{\tau C}{r} \cdot \left[1 - V/V_B^{-x}\right] - \alpha V_B \left[V/V_B\right]^{-x} \end{aligned}$$

where

$$x = \frac{(r - \delta - 0.5\sigma^2) + \sqrt{(r - \delta - 0.5\sigma^2)^2 + 2\sigma^2 r}}{\sigma^2}$$

and

$$V_B = \frac{(1-\tau)C}{r}\frac{x}{1+x}$$

Debt value is given by

$$D(V) = \frac{C}{r} + \left[(1-\alpha)V_B - C/r\right]\left[V/V_B\right]^{-x}$$

Hence equity value is

$$\begin{aligned} E(V) &= v(V) - D(V) \\ &= V - (1-\tau)C/r + \left[(1-\tau)C/r - V_B\right]\left[V/V_B\right]^{-x} \end{aligned}$$

2.A.3 The Leland/Toft Model

Firm value is the same as in Leland(1994). Debt value is given by

$$D(V) = C/r + (P - C/r)\left[\frac{1-e^{-rT}}{rT} - I(T)\right] + \left[(1-\alpha)V_B - C/r\right]J(T)$$

The bankruptcy barrier

$$V_B = \frac{\frac{C}{r}(\frac{A}{rT} - B) - \frac{AP}{rT} - \frac{\tau C x}{r}}{1 + \alpha x - (1-\alpha)B}$$

where

$$\begin{aligned} A = {} & (z-a) - 2zN(z\sigma_V\sqrt{T}) + 2ae^{-rT}N(a\sigma_V\sqrt{T}) - \frac{2}{\sigma_V\sqrt{T}}n(z\sigma_V\sqrt{T}) \\ & + \frac{2e^{-rT}}{\sigma_V\sqrt{T}n(a\sigma_V\sqrt{T})} \end{aligned}$$

$$B = (z-a) - (2z + \frac{2}{z\sigma^2 T})N(z\sigma_V\sqrt{T}) + \frac{1}{z\sigma^2 T} - \frac{2}{\sigma_V\sqrt{T}}n(z\sigma_V\sqrt{T})$$

$$I(T) = \frac{1}{rT}\left[G(T) - e^{-rT}F(T)\right]$$

$$J(T) = \frac{1}{z\sigma_V\sqrt{T}}\Big[-\big(\frac{V}{V_B}\big)^{-a+z}N(q_1(T))q_1(T) + \big(\frac{V}{V_B}\big)^{-a-z}N(q_2(T))q_2(T)\Big]$$

$$F(t) = N(h_1(t)) + \frac{V}{V_B}\big)^{-2a}N(h_2(t))$$

$$G(t) = \left(\frac{V}{V_B}\right)^{z-a}N(q_1(t)) + \left(\frac{V}{V_B}\right)^{-z-a}N(q_2(t))$$

and

$$q_1(t) = \frac{-b - z\sigma_V^2 t}{\sigma\sqrt{t}}; \qquad q_2(t) = \frac{-b + z\sigma_V^2 t}{\sigma\sqrt{t}}$$

$$h_1(t) = \frac{-b - a\sigma_V^2 t}{\sigma\sqrt{t}}; \qquad h_2(t) = \frac{-b + a\sigma_V^2 t}{\sigma\sqrt{t}}$$

$$a = \frac{r - \delta - \frac{\sigma_V^2}{2}}{\sigma_V^2}; \qquad b = ln\big(\frac{V}{V_B}\big); \qquad z = \frac{\sqrt{(a\sigma_V^2) + 2r\sigma_V^2}}{\sigma_V^2}$$

Chapter 3

The Executive Turnover Risk Premium

3.1 Introduction

This paper investigates the idea that turnover risk is priced in executive compensation. Our motivation for studying this question is that the willingness of boards to fire CEOs and executive compensation levels exhibit a strikingly similar development over the past decades. If CEOs expect contractual compensation agreements, which frequently require cancelation of unvested equity-based pay in case of turnover, to be rigorously enforced, the expected value to CEOs of current compensation packages may be significantly lower than usually assumed. In addition, there may be important career concerns for a CEO who is fired in that, on average, fired CEOs earn less and manage smaller firms in the future. To guarantee participation of CEOs, efficient contracts may, therefore, require rising compensation as turnover risk rises.

In this paper, we provide empirical evidence on the relationship between expected hazard rates for CEOs, estimated from turnover data, and compensation actually received. We find a statistically and economically strongly significant turnover risk premium: On average, a one-percentage point increase in the forced turnover rate goes hand in hand with a 10 percent increase in compensation, a quite sizable effect. We also show that these results are unlikely to be driven by reverse causation.

We begin in section 3.2 by presenting some stylized facts on executive pay and forced turnover. We find that the secular rise of CEO pay occurred hand in hand with a rise in forced turnover of CEOs. Indeed, forced turnover of CEOs of major U.S. corporations has increased massively over the past 20 years. While only about 1% of CEOs of major U.S. companies were fired in 1980, 3%-4% were fired in 2000, and 5% in 2005.

In section 3.3 we propose two channels through which forced turnover and compensation levels are likely to be linked, and estimate the theoretical effect on the expected value of compensation that turnover risk generates through these channels. First, forced turnover can lead to loss of the unvested portions of executive pay. Accounting for this possibility lowers the expected value of executive pay. Second, forced turnover has adverse labor market consequences. Typically, fired CEOs earn far less and manage smaller companies later in their professional lives. Both elements suggest that there may be a turnover risk premium that varies in the cross-section and across time and that can potentially be an important determinant of executive compensation levels. Our numerical results for the risk premium that can be attributed to these monetary consequences of forced turnover reveal that a one percentage point increase in the forced turnover rate should be compensated with about 2 to 3 percent more in terms of total compensation.

While, according to our estimates, the mere monetary consequences of turnover appear to be modest, other personal implications such as loss of seniority or reputation arguably impose additional costs on CEOs. Thus the total turnover risk premium, as reflected in compensation actually received, is likely to exceed the purely monetary component. Estimating this empirical turnover risk premium is the task of section 3.4. We use detailed turnover and compensation data for the largest U.S. corporations from 1993 to 2001. In a first step we estimate a hazard rate which the CEO is exogenously exposed to, i.e., which does not depend on management skill or entrenchment, as it is mainly for this exogenous part of the hazard rate that the CEO can expect to be compensated for. Consistent with this idea we estimate hazard rates which are predicted by year, industry affiliation, and industry performance. This is motivated by a major theme in the recent literature on CEO turnover, namely, that boards do not appear to filter out industry performance when judging CEOs (Jenter and Kanaan, 2006).

We not only find these predicted hazard rates to be statistically significantly correlated with executive compensation levels, we also find substantial economic significance. Our estimates reveal that for the median CEO a one percentage point increase in firing risk is associated with about $200,000 more in terms of total compensation. In relative terms this corresponds to a turnover risk premium of around ten percent for a one percentage point increase in turnover risk. The effect is twice as large when the pay package was negotiated for the first time. For first-year CEOs, a one percentage point turnover probability increase is worth around $400,000 for the median CEO.

Although the theoretical case for a turnover risk premium is plausible, we also explicitly address potential endogeneity issues in our empirical analysis. First, we find that in the years preceding turnover, CEOs who are fired do not earn more than CEOs who leave voluntarily. This is contrary to a reverse causation explanation where increased turnover risk results from higher pay because of heightened performance expectations and accountability of CEOs. Second, we observe that, following forced turnover, total compensation sharply increases while the proportion of equity-based pay tends to decrease. Thus, if total compensation were driven only by the risk inherent in equity-based pay, this would imply that we should observe lower total compensation following forced turnover. The fact that we observe higher compensation, therefore, implies that we may underestimate rather than overestimate, the impact of forced turnover on total compensation.

These findings add to the literature on executive compensation and corporate governance. Other papers have focused on the role of turnover as an incentive device (Jensen and Murphy, 1990; Subramanian et al., 2002; Hallman et al., 2005) and the implications of termination risk on managerial risk-taking (Chakraborty et al., 2004). In contrast to these papers, our focus is on the level of pay. Recent theories have intended to show that the secular rise of executive pay can be explained by the similar increase in firm size within a framework of competitive markets and rare skills (Gabaix and Landier, 2006) or a change in the composition of managerial skills needed to manage a corporation (Murphy and Zaboinik, 2004) or managerial entrenchment (Bebchuk and Fried, 2004). However, we are not aware of any other study that has tried to draw a causal connection between forced turnover and executive pay. Our contribution, therefore, is to show that turnover risk remains a powerful determinant of executive compensation even after controlling for other factors known to influence pay.

3.2 Executive turnover and executive compensation

We begin by presenting some stylized facts on executive turnover and executive compensation. The suggestive evidence presented in this section provides the motivation for our theoretical analysis of the link between turnover and compensation and the subsequent empirical analysis.

3.2.1 CEO compensation

To set the stage, consider Figure 3.1. This graph shows average CEO pay between 1993 and 2005 in the S&P 1500 firms. The levels reflect much of the unease that many commentators have with the development of executive compensation: a dramatic increase in the level of executive pay. But besides this, other aspects are noteworthy: First, after 2000 average CEO pay has actually declined for a few years to rise again only after 2003. Second, also following 2000, the composition of CEO pay has changed substantially. Bonuses (immediate cash rewards) have become much more important recently, while the share of equity-based pay (deferred rewards) in CEOs' compensation packages has decreased.

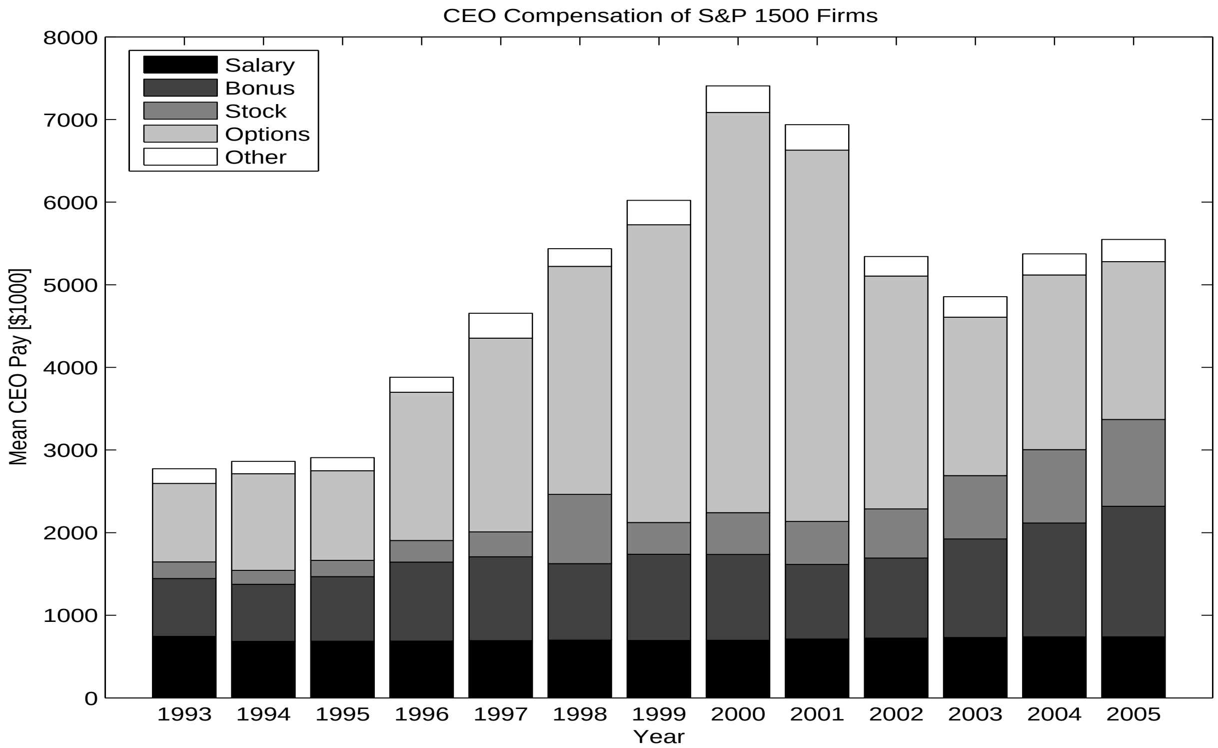

Figure 3.1: Average compensation of S&P 1500 CEOs. The figure shows the average compensation of S&P 1500 CEOs over the period 1993-2005. Pay levels are converted to 2005 dollars using the consumer price index provided by the U.S. Bureau of Labor Statistics. Source: ExecuComp

3.2.2 CEO turnover

We use data from four recent studies (Dezsö, 2006; Huson et al., 2001; Jenter and Kanaan, 2006; Booz-Allen-Hamilton, 2005) to explore the actual extent of forced turnover.[1] Dezsö (2006) extends the Huson et al. (2001) data set on CEO turnover and we refer to the extended data set as DHPS, and to the other studies as JK, and BAH, respectively. Identifying a turnover as "forced" is not obvious, and requires careful hand-collection of data.[2]

While the data sets differ in the details, Figures 3.2-3.4 all tell the same basic story:

[1]The Booz-Allen-Hamilton study provides aggregated turnover data only. It is, however, the only study that covers the period after 2001, and we use all data available at this point. Acquiring detailed data on forced CEO turnover in S&P 1500 firms after 2001 is part of our ongoing efforts.

[2]Therefore, we are extremely grateful to the cited authors for providing us with the data. The methodology of the first three cited studies follows Parrino (1997). All departures for which the press reports state that the CEO is fired, forced out, or retires or resigns due to policy differences or pressure, are classified as forced. Turnovers of CEOs below the age of 60 which have not been classified as forced by the press criterion, are classified as forced if the articles do not report the reason to be death, poor health, or acceptance of another position or the articles report that the CEO is retiring but does not announce the retirement date at least 6 months before the succession. For further details, see the original papers.

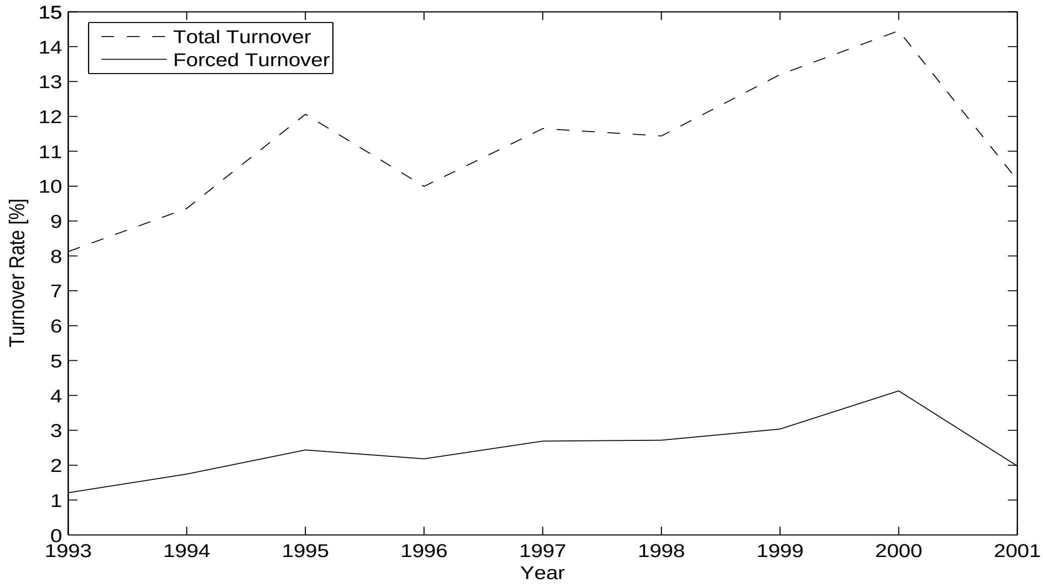

Figure 3.2: Turnover rates for CEOs in the ExecuComp database. The figure shows turnover rates for CEOs in the ExecuComp database over the period 1992-2001. Underlying data are from Jenter and Kanaan (2006)

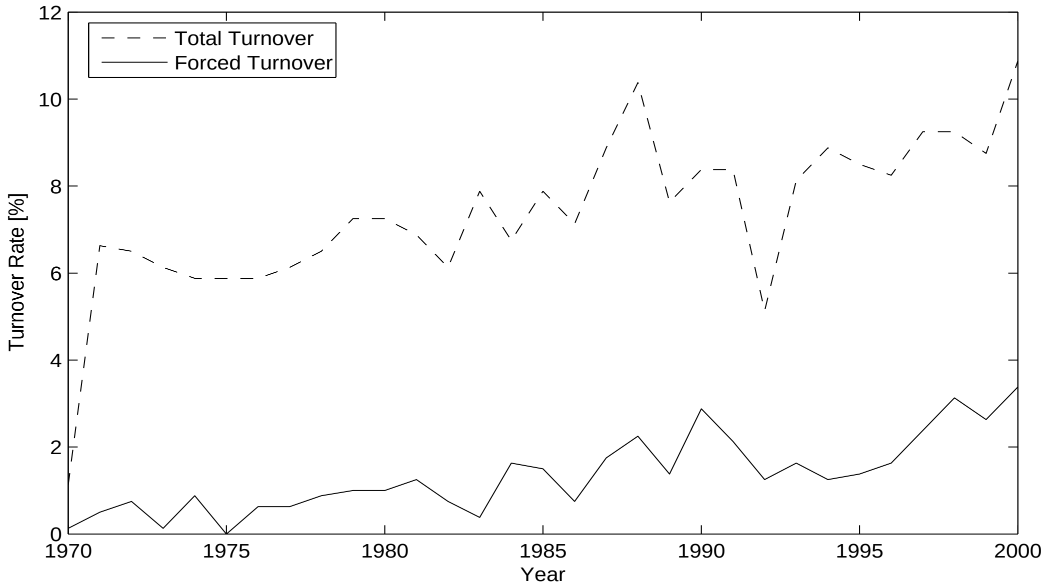

Figure 3.3: Turnover rates for CEOs of the Fortune 800 firms. The figure shows turnover rates for CEOs of the Fortune 800 firms over the period 1975-2000. Underlying data are from Huson et al. (2001) and Dezsö (2006)

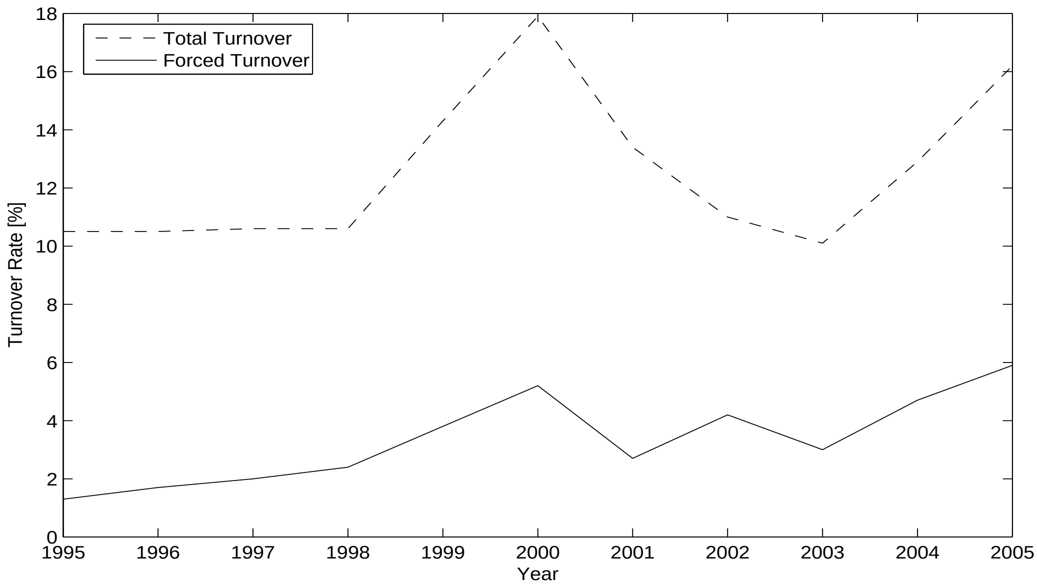

Figure 3.4: Turnover rates for CEOs of U.S. firms among the largest 2500 firms worldwide. The figure shows turnover rates for CEOs of U.S. firms among the largest 2500 firms worldwide over the period 1995-2005. Underlying data are from Booz-Allen-Hamilton (2005). We interpolate linearly for years not available in the original data (1996, 1997, and 1999).

There has been a secular rise in forced turnover rates. The increase has become especially salient in the 1990s, with the evidence suggesting that nowadays a 4% to 5% chance of forced CEO turnover per year is not unusual for the largest U.S. corporations. Although substantially lower than voluntary turnover, this nonetheless represents a significant threat, especially when considering the involuntary turnover risk a CEO faces over his entire prospected tenure. For a newly hired CEO the yearly turnover probabilities imply a 25% to 30% probability of getting fired during a 7-year tenure.

Another interesting feature is that the BAH data show a decrease in turnover after 2000, before it rises again; executive pay shows a similar pattern. Combining the data on executive turnover and compensation suggests that the two may be connected: Indeed, the raw correlations between median CEO pay and forced turnover for the DHPS, JK, and BAH data, respectively, are 0.45, 0.76, and 0.88. By contrast, the correlations between median CEO pay and *voluntary* turnover in the three datasets are much lower, -0.29, 0.22, and 0.02, respectively. While this is at most suggestive evidence as it relies on only a few data points it motivates us to explore a possible causal relation between forced turnover and compensation in more detail.

The non-monotonic pattern of CEO pay after 2000 is, indeed, a feature that may allow us to re-evaluate many of the arguments that have been advanced in explaining the level and trend in executive pay. Recent theories have intended to show that the secular rise of executive pay can be explained by the similar increase in firm size within a framework of competitive markets and rare skills (Gabaix and Landier, 2006) or a change in the composition of managerial skills needed to manage a corporation (Murphy and Zaboinik, 2004). Other authors have advocated the managerial entrenchment view in explaining excessive executive pay (Bebchuk and Fried, 2004). It is clear, however, that these theories have difficulties explaining the non-monotonic evolution of CEO pay in recent years.

On the other hand, some observers have argued that total compensation may to a large extent be driven by stock market valuations (Hall and Murphy, 2003), as a significant share of CEO pay is equity-based. This would explain not only the general rise but also the non-monotonic pattern of CEO pay in the years following the burst of the dot-com bubble. A skill-related explanation in the spirit of (Gabaix and Landier, 2006) would also be consistent with this pattern if market capitalization is used as a proxy for firm size. While stock market valuation is certainly an important determinant of CEO pay, we show in our empirical section below that forced turnover risk is a highly significant determinant of total compensation even after controlling for market value, whether in the time-series or the cross-section.

3.3 The link between turnover and compensation

The basic conclusion we draw from these facts is that while CEOs have undoubtedly been able to secure a dramatic increase in pay, they are also facing increasing risk of involuntary turnover. There are at least two powerful reasons why a greater probability of forced turnover may be associated with greater pay levels. First, a CEO may lose the unvested portion of his equity-based pay in case of forced turnover. Accounting for this possibility reduces the expected value of CEO pay. This channel links turnover risk and compensation through concerns about the impact of forced turnover on compensation received in the *past*. Second, forced turnover may have severe consequences for CEOs' employment and earnings opportunities later in their professional lives. Hence, CEOs may be compensated for the expected negative earnings impact of turnover risk, in particular if turnover occurs for reasons largely outside the CEOs control, such as an industry decline. This second channel links turnover risk and compensation through career concerns, i.e. concerns about *future* earnings opportunities.

We begin by sketching a model which explicitly accounts for the first channel generating a turnover risk premium, the forfeiture of past unvested compensation, and apply our valuation model to actual compensation packages of S&P1500 CEOs. Our results show that forfeiture risk can explain only a small part of the evolution of CEO pay. We then investigate the second channel, concerns about diminished earnings opportunities following turnover. To this end, we develop a simple model which approximates the discount to current compensation due to turnover-induced monetary career concerns. Applying the model to a realistic range of parameters, we find that monetary career concerns can explain much higher turnover risk premia than forfeiture.

3.3.1 The forfeiture risk premium

While some companies require the cancelation of unvested equity-based pay only in case of voluntary departure, most equity compensation plans do not distinguish between forced and voluntary turnover. Instead, they contain general formulations requiring forfeiture of unvested stocks and options when the employment terminates (without specifying the reason). Other compensation plans explicitly provide for cancelation in case of forced turnover.[3] Of course, in case of forced CEO turnover, severance agreements may in some cases compensate for the forfeiture of unvested stocks and options, either through lump-sum payments or by waiving forfeiture rules altogether. However, Rusticus (2006), Dahiya and Yermack (2007), and Sletten and Lys (2006) show that CEOs can in general expect only relatively small amounts of severance to be contractually guaranteed.[4] The biggest portion of severance payments, thus, is discretionary. Arguably, CEOs cannot, ex ante, count on these deviations from contractual agreements, especially in times when they face stronger and more assertive boards and active shareholders.

To estimate an upper bound for the discount to executive compensation of forfeiture risk, we assume that contractual provisions require cancelation of unvested equity-based pay and immediate exercise of vested equity-pay components. We use the certainty-equivalent approach in the spirit of Lambert et al. (1991) and Hall and Murphy (2002), but adjust for the possibility of cancelation and accelerated exercise of unvested options and

[3]For example, Viacom's 2006 long-term management incentive plan states that "[...] in the event that [...] the Participant ceases to be an employee of the Company by reason of the voluntary termination by the Participant or the termination by the Company [...] all rights with respect to Stock Options that are not vested as of such event will be relinquished" (see http://www.sec.gov/Archives/edgar/data/1339947/000119312507086534/ddef14a.htm)

[4]While only about 50% of CEOs' employment agreements contain an explicit severance provision, the median contracted amount of severance is only about 2 to 3 times base salary and bonus.

stocks. In the following we use the term "subjective value" synonymous with "certainty equivalent value" to highlight the feature that the certainty equivalent approach accounts for individual preferences, endowment and portfolio diversification of the executive. For brevity of exposition we discuss only the main aspects of the model in the main body of the paper. The details of the derivations are relegated to the appendix.

We define the random time T_F as the time the CEO is forced out of office and assume a constant hazard rate of forced turnover with density function f_{T_F}:[5]

$$f_{T_F}(t) = \lambda e^{-\lambda t} \qquad t \in [0, \infty), \tag{3.1}$$

where λ is the hazard rate.

We consider the payoffs from option and stock grants separately. First, consider the payoff of an option grant.[6] We use the following notation: $\mathbf{1}_{T_F < T_V \wedge T_R}$ is an indicator variable that is equal to 1 if the condition in the subscript holds. For example, in this case the variable is 1 if the CEO is forced out at a date before his options are vested and before he retires. The CEO's wealth at time T from the option grant is then given by

$$\begin{aligned} W_T^O &= \mathbf{1}_{T_F < T_V \wedge T_R} \cdot 0 + \mathbf{1}_{T_F \geq T_V \wedge T_R} \mathbf{1}_{T_F < T_R \wedge T} \cdot n[P_{T_F} - X]^+ e^{r(T-T_F)} + \mathbf{1}_{T_F \geq T_R \wedge T} \cdot n[P_T - X]^+ \\ &= \mathbf{1}_{T_F \geq T_V \wedge T_R} \mathbf{1}_{T_F < T_R \wedge T} \cdot n[P_{T_F} - X]^+ e^{r(T-T_F)} + \mathbf{1}_{T_F \geq T_R \wedge T} \cdot n[P_T - X]^+ \end{aligned} \tag{3.2}$$

where P_{T_F} and P_T are the stock prices at T_F and T, respectively, n is the number of options in the grant, X is the strike price, and r is the risk-free rate. The first term indicates the event that the CEO is fired before the options vest and before he retires in which case the payoff is zero. The second term indicates the event that the CEO is fired between the vesting date and the smaller of his retirement and the option's expiry date. This is the case

[5]One can, in principle, accommodate the feature that the probability of forced turnover, conditional on survival, depends on factors such as time, industry performance, and firm performance by specifying the hazard rate as a function of a set of these variables. In the empirical section, we use time- and industry-specific hazard rates.

[6]We consider European options in our main analysis. This assumption is restrictive and does not, in particular, allow for the empirically documented early exercise of executive stock options (except for involuntary exercise of vested options in the event of turnover). By doing so, we retain tractability and intuition of the model relative to American option valuation which necessarily relies on simulation (see Carpenter (1998), Carpenter (2000) and Ingersoll (2006) for an analysis of subjective values of American style options). In any case, the differential effect of turnover/cancelation on European and American option values is likely to be negligible as cancelation occurs in the vesting period when the option cannot be exercised anyway.

of accelerated exercise in which the payoff of a single option is $[P_{T_F} - X]^+$, the intrinsic value at departure. We assume that the CEO receives this payoff in cash and invests it in the risk-free asset until T. The third term represents the case when the CEO remains in office until regular retirement or option maturity. In this case he gets the intrinsic value of the option at time T.

Analogously, the CEO's payoff from his restricted stock grant is given by

$$\begin{aligned} W_T^S &= \mathbf{1}_{T_F<T_V\wedge T_R} \cdot 0 + \mathbf{1}_{T_F\geq T_V\wedge T_R}\mathbf{1}_{T_F<T_R\wedge T} \cdot sP_{T_F}e^{r(T-T_F)} + \mathbf{1}_{T_F\geq T_R\wedge T} \cdot sP_T \\ &= \mathbf{1}_{T_F\geq T_V\wedge T_R}\mathbf{1}_{T_F<T_R\wedge T} \cdot sP_{T_F}e^{r(T-T_F)} + \mathbf{1}_{T_F\geq T_R\wedge T} \cdot sP_T \end{aligned} \tag{3.3}$$

where the first term refers to the event that the CEO is dismissed before vesting and retirement, in which case the payoff is zero, and the second term indicates the complementary event, in which case the CEO gets the full value of his stock grant at T_F. As with the option payoff at T_F, we again assume that the stock is sold and the proceeds are invested in the risk-free asset.

Assuming that the CEO has outside wealth W_0 invested at the risk-free rate, r, his total wealth at time T is

$$W_T = W_0e^{rT} + W_T^O + W_T^S \tag{3.4}$$

If instead of the risky, equity-based compensation the CEO were awarded the amount C in riskless cash, his wealth at time T is given by

$$W_T^C = (W_0 + C)e^{rT} \tag{3.5}$$

The certainty equivalent value of the CEO's entire package of equity-based compensation is defined as the amount C^* that equates expected utilities of equations (3.4) and (3.5).

Figure 3.5 shows certainty equivalent values for options with typical characteristics and assuming a range of different hazard rates. The two panels in figure 3.5 also illustrate the sensitivity of the certainty equivalent value with respect to volatility. In Panel A we use a volatility of 41%, the median volatility in 2000. Panel B shows option values when assuming a volatility of 29%, the average volatility over the period 1993-2005. The graphs indicate that the discount due to forfeiture can be large potentially, but relative to certainty equivalent values without forfeiture risk the discount is sizable only when volatility is low.

Intuitively, this is because the two sources of risk are complementary. When volatility is large, certainty equivalent values are depressed so much that the additional effect of cancelation becomes negligible. Forfeiture risk has important valuation effects only when volatility is low, so that certainty equivalent values without forfeiture risk are close very to Black-Scholes values.

In order to estimate the potential impact of forfeiture risk on executive compensation packages we adapt our methodology to account for the different components of pay (salary, bonus, restricted stock and options). The technical details are given in the appendix. We assume a hazard rate equal to the average empirical forced turnover rate in a given year. These empirical turnover rates are taken from Jenter and Kanaan (2006) for 1993-2001 and from Booz-Allen-Hamilton (2005) for 2002-2005.

Figure 3.6 illustrates the results. The bar heights correspond to the mean risk-neutrally valued CEO pay, while the solid and dotted lines correspond to certainty equivalent values, with and without account for forfeiture risk, and assuming relative risk aversion of $\rho = 2$.

The striking feature is that subjective values of CEO compensation packages accounting for turnover risk are *not* predicted to be substantially below those without turnover for most of the sample period. The sources of this result are two-fold: First, turnover discounts to total compensation are much smaller than those pertaining to stock options or restricted stock only, as the non-deferred part of compensation is unaffected by turnover. Second, certainty equivalent values of options are very sensitive to volatility. Thus, in the years 1998 to 2000, when turnover rates were rising substantially, their effect on turnover-adjusted subjective values is negligible, primarily because the increase in stock return volatility dominates the turnover effect. Forfeiture risk has a noticeable effect only in the latest years in the sample when turnover rates are high and volatility is low. In 2005, forfeiture risk depresses mean subjective values of CEO pay by about \$300,000. Given a turnover hazard rate of 5% in that year, this implies about a \$60,000 decrease in terms of total certainty equivalent compensation for a 1% increase in turnover risk. Over the entire sample period the effect is much smaller, however.

In sum, our numerical results suggest that forfeiture risk cannot account for a significant part of the development of CEO pay levels. A one percentage point increase in turnover risk for a typical CEO is likely to be associated with a decrease in the certainty equivalent of compensation from his present job on the order of \$20,000 to \$40,000, or one half to one percent of total risk-neutral compensation. This is only a tiny fraction of the turnover risk premium we estimate from the data in our empirical section below.

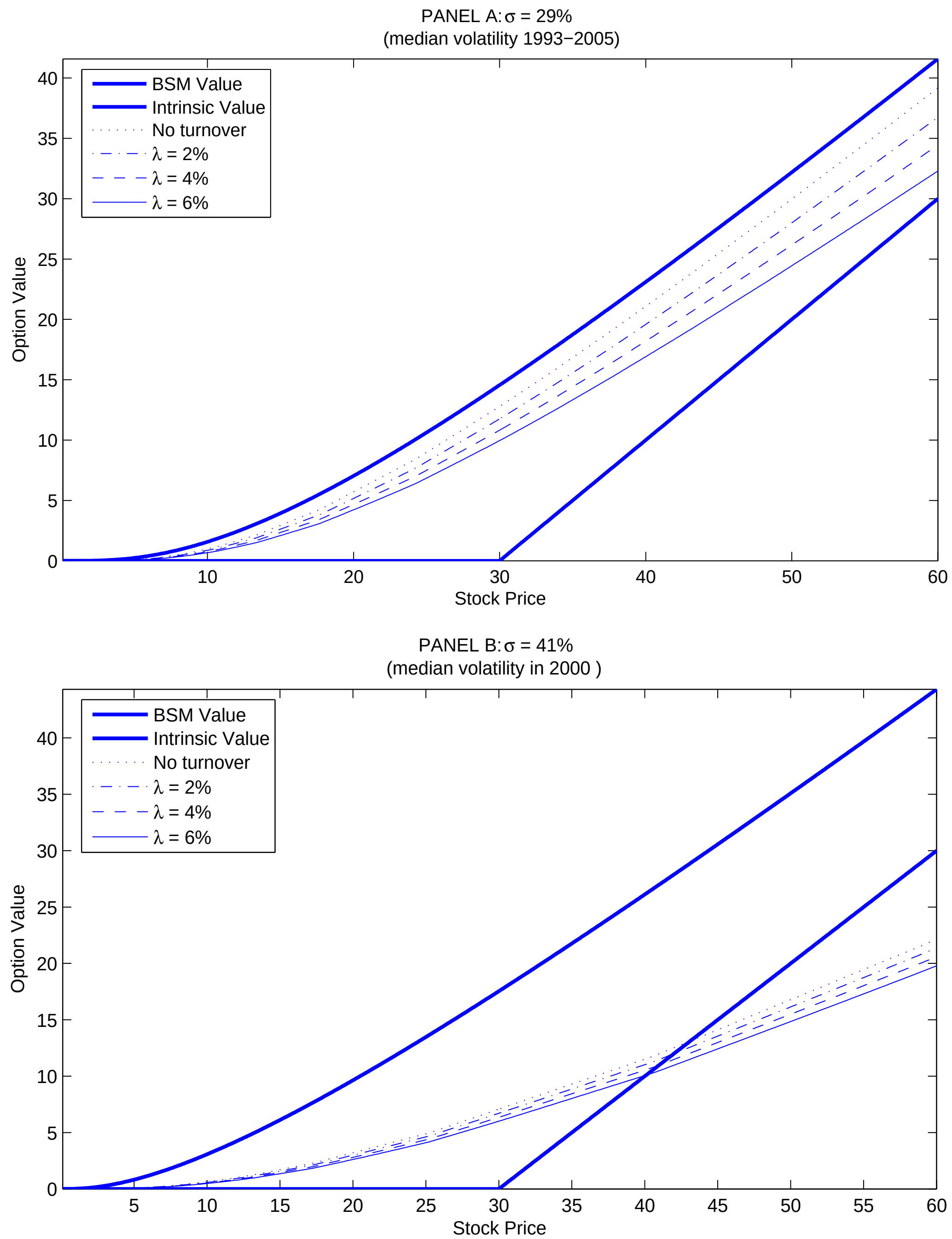

Figure 3.5: Executive option values. Executive values for 10-year options with an exercise price of \$30 are estimated using the certainty equivalence approach. Certainty equivalents are computed numerically assuming the executive has constant relative risk aversion, $\rho = 2$, safe wealth, W_0, equal to the greater of \$5 million and four times total compensation, and the fraction α of total wealth invested in company stock. Stock returns are assumed to be lognormally distributed with mean $\mu = r_f + \beta(r_m - r_f)$ according to the Capital Asset Pricing Model (CAPM), and volatility σ. The parameters $r_f = 5\%$, $\beta = 0.96$, and $\alpha = 37\%$ are chosen as the median values of S&P500 firms/CEOs, 1993-2005. The vesting period is assumed to be 2.5 years, consistent with a straight vesting schedule over five years where 20% of options vest each year. The simulations shown in Panel A are based on $\sigma = 41\%$, the median volatility in 2000, which is also the highest in the sample period. Panel B uses $\sigma = 29\%$, the median volatility over the entire sample period 1993-2005.

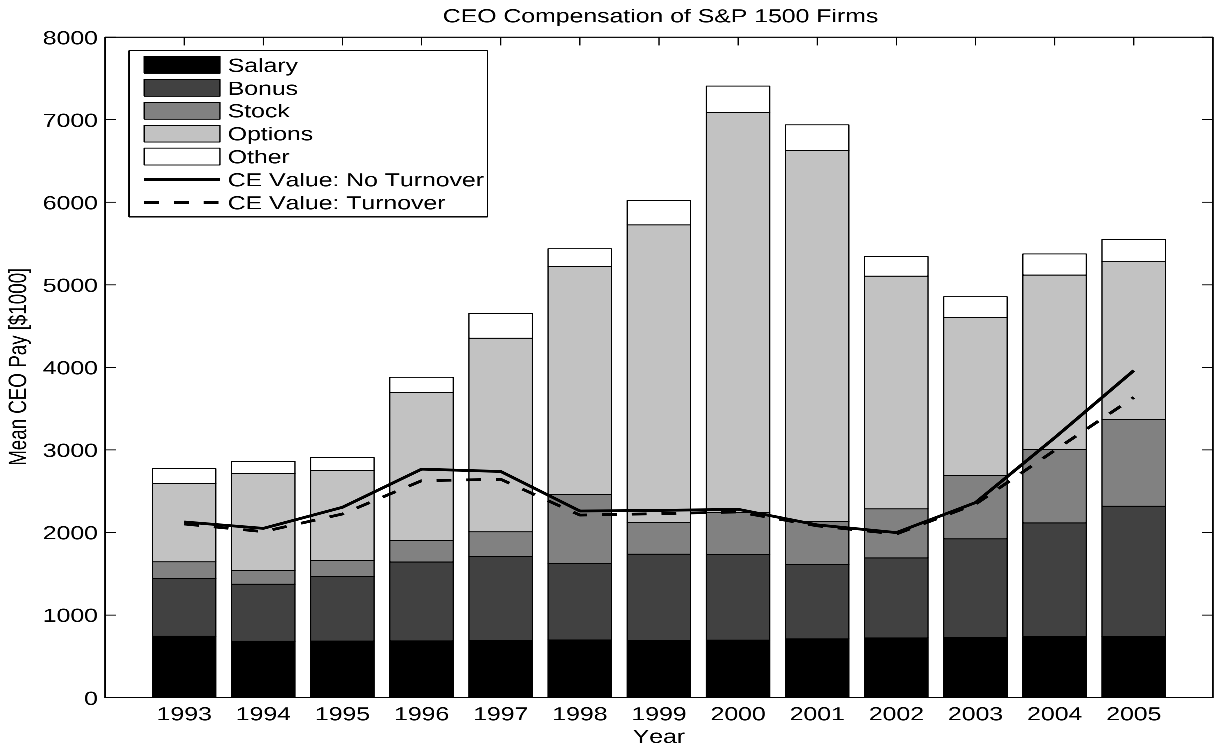

Figure 3.6: Risk-neutral and risk-adjusted CEO pay for S&P 1500 firms. The figure displays the mean risk-neutral and risk-adjusted CEO pay for S&P 1500 firms in constant 2005 dollars, 1993-2005. Total risk-neutral compensation is indicated by bar height. Executive (subjective) values without forfeiture risk are given by the dashed line. Subjective values accounting for forfeiture risk are given by the solid line. The percentage value below the years gives the median annualized stock return volatility calculated from monthly data over 48 months. Subjective values of compensation are estimated using the certainty equivalence approach and are defined as the amount of safe cash the CEO would be indifferent to exchanging for his risky compensation package. Certainty equivalents are computed numerically assuming the CEO has constant relative risk aversion of 2. The CEO's non-firm-related safe wealth is assumed to be the greater of $5 million and four times total compensation. Stock returns are assumed to be normally distributed with mean $r_f + \beta \cdot (r_m - r_f)$ and volatility σ. β and σ are estimated using monthly stock and CRSP value-weighted index returns over 48 months. r_f is the yield of 1-year U.S. Treasury Bills. The equity premium $(r_m - r_f)$ is assumed to be 6.5%. To calculate subjective values with forfeiture risk we assume a vesting period (for restricted stock and options) of 2.5 years, consistent with the average vesting period implied by a straight vesting schedule over five years where 20% of securities vest each year. The time to regular retirement is given by the greater of zero and 65 less the CEO's age.

3.3.2 Risk premia due to career concerns

Getting fired may, of course, have far more detrimental consequences to a CEO than the potential loss of some of his past compensation. Indeed, it may imply a substantial loss of future employment opportunities and compensation. Fee and Hadlock (2004) provide intriguing evidence that this ought to be a major concern for CEOs. They find that (1) in three quarters of cases of turnovers (even voluntary ones), new salaries are lower than old salaries, (2) only a third of CEOs who were fired reappear at other employers in their sample, (3) those who do obtain new employment after having been fired do so at firms approximately one-tenth the size of their former employer, and that (4) those for whom salary data is available (and who are, therefore, likely to have gotten the best new jobs), experience pay cuts on the order of 20%.

While the 20% pay loss arguably understates the average earnings consequences of forced turnover, Fee and Hadlock's findings on the size of subsequent employers allows one to obtain a second approximate benchmark. We can translate the decrease in firms size by a factor of ten into the corresponding pay reduction using the coefficient of log firm size in a regression of log total compensation on firm size (and control variables). Consistent with other studies on CEO compensation, we find this coefficient to be approximately 0.40 (see empirical section below). This implies that a ten-fold decrease in firm size is associated with a 4-fold decrease in pay. In other words, a dismissed CEO is likely to earn about one quarter of his pre-turnover pay, or incur a 75% pay loss. Note that both the 20% and 75% estimates are conditional on the CEO finding a new employer at all. Altogether this suggests that an expected pay reduction of 50% or more is not unreasonable.

In order to estimate the turnover discount to CEO compensation due to the risk of future pay loss, we develop a simple model which retains a certainty equivalent intuition similar to the one described in section 3.3.1 above. Our aim is to compute the value of safe compensation, paid in full until retirement, which yields the same expected lifetime income as the compensation actually received, which may be subject to future pay reductions if turnover occurs. In other words, the certainty equivalent computed in this way answers the following question: What is the CEO's current compensation worth adjusting for the fact that the turnover risk associated with his current job may imply severe reductions of future pay?

In comparison to the certainty equivalent approach presented in the last section, the model presented here differs in two important aspects. First, as we want to value the cumulative monetary consequences of pay losses that may occur in the future, we need to use the concept of lifetime labor income. To do this, we have to make assumptions about the evolution of CEO pay in the future with and without turnover. We assume, for simplicity that the CEO is paid an amount equal to his current compensation until retirement if he is not fired. If he is fired at some point between the current year and retirement he will incur a reduction in pay in the amount D in the years following turnover. The assumption of constant pay is not critical as the certainty equivalents are unchanged if we assume a constant growth rate of income instead. Second, we assume that CEOs are risk-neutral. This simplifies calculations significantly since present values are calculated as simple discounted expectations of future pay. A certainty equivalent framework akin to the one used in the previous section would require a range of additional assumptions regarding the composition of future pay, and other parameters such as future stock prices and volatilities.

Wealth losses. We begin by modeling present values of turnover-induced wealth losses. Let W_t denote the compensation a CEO would receive in year t in the future in case he has not been fired before. Further, assume that, if the CEO is fired, he incurs a pay reduction in the amount of D in the years following his dismission. Then $\tilde{W}_t = W_t - D \cdot 1_{(T_F<t)}$ is the "turnover-risky" compensation in year t in the future, where $1_{(T_F<t)}$ is an indicator equal to one if the CEO has been fired before t and zero otherwise. In a risk-neutral framework the present value of expected future lifetime income is given by the expected discounted value of the risky compensation stream $\tilde{W}_t$ over $t = 1, 2, ..., T_R$, where T_R denotes the number of years until retirement:

$$E[W_+] = E[\sum_{t=1}^{T_R} e^{-\gamma t}\tilde{W}_t] = \sum_{t=1}^{T_R} e^{-\gamma t}(W_t - D \cdot P[T_F < t]) \tag{3.6}$$

where the subscript "+" indicates that only future compensation is taken into account when calculating the present value of pay, and γ is the discount factor.

The wealth loss due to turnover risk is given by

$$E[L_+] = \sum_{t=1}^{T_R} e^{-\gamma t} D \cdot P[T_F < t] \tag{3.7}$$

which can also be written as

$$E[L_+] = \sum_{t=0}^{T_R-1} L(t)P[T_F = t] \tag{3.8}$$

where $L(t) = \sum_{i=t+1}^{T_R} e^{-\gamma i} D$ is the present value of the life time pay loss conditional on being fired in year t.

Certainty equivalents. We define the certainty equivalent of compensation as that amount of (turnover-) safe pay which yields a present value of future life time income equal to the (turnover-) risky pay. The present value of the turnover-safe compensation paying cash amount C in every year until retirement is

$$E[W_+^C] = C \cdot \sum_{t=1}^{T_R} e^{-\gamma t} \tag{3.9}$$

The certainty equivalent of turnover-risky compensation is the safe pay C^* which solves

$$E[\sum_{t=1}^{T_R} e^{-\gamma t}\tilde{W}_t] = C^* \cdot \sum_{t=1}^{T_R} e^{-\gamma t} \tag{3.10}$$

so that the certainty equivalent can be computed in closed form as

$$C^* = \frac{E[\sum_{t=1}^{T_R} e^{-\gamma t}\tilde{W}_t]}{\sum_{t=1}^{T_R} e^{-\gamma t}} \tag{3.11}$$

Table 3.1 shows the percentage difference between the actual compensation, $\tilde{W}_t$, which is subject to turnover risk, and the certainty equivalent of compensation obtained from equation (3.11) for a range of parameter values. This percentage difference can be interpreted as the discount to current compensation due monetary career concerns. Panel A contains the results assuming 5 years to retirement, while Panels B and C report estimates assuming the CEO is 10 and 15 years from retirement, respectively. These numbers correspond to the 25%, 50% and 75% quantiles of the age distribution in our sample of ExecuComp CEOs assuming a retirement age of 65.

The discounts increase with the turnover rate and the assumed pay cut following dismission. They also rise with the length of the CEO's prospective career. Intuitively, this captures the idea that CEOs near retirement have little to lose should they be fired whereas young executives may have to cope with the adverse consequences of forced turnover for a long time. While the direction of the effects of turnover rate, pay cuts, and years to retirement is obvious by construction of the model, the main interest lies in the magnitude of these effects. For the typical CEO who has 10 years to retirement, and assuming his earnings opportunities would be reduced by 50% if he is fired, an increase in the turnover rate from 1% to 5% (which roughly equals the rise in turnover risk from 1993 to 2000) would result in a 7% discount to his compensation. In other words, to keep the CEO indifferent, a 7% increases in pay would be required to compensate him for 4 percentage points more turnover risk. This corresponds to a 1.8% increase in pay for a one percentage

Table 3.1: Discounts due to turnover-induced future pay loss. The table displays the percentage difference between actual pay, $\tilde{W}_t$, which is subject to turnover risk, and the safe amount of pay, C^*, which yields the same expected present value of lifetime income.

PANEL A: 5 years to retirement

Turnover	Pay loss following turnover		
rate	25%	50%	75%
1%	0.47	0.94	1.41
2%	0.93	1.86	2.80
3%	1.38	2.77	4.15
4%	1.83	3.65	5.48
5%	2.26	4.52	6.79

PANEL B: 10 years to retirement

Turnover	Pay loss following turnover		
rate	25%	50%	75%
1%	1.00	1.99	2.99
2%	1.94	3.89	5.83
3%	2.84	5.69	8.53
4%	3.70	7.40	11.10
5%	4.51	9.03	13.54

PANEL C: 15 years to retirement

Turnover	Pay loss following turnover		
rate	25%	50%	75%
1%	1.46	2.92	4.38
2%	2.81	5.61	8.42
3%	4.05	8.10	12.15
4%	5.20	10.40	15.60
5%	6.26	12.52	18.78

point increase in forced turnover risk.

Combining the impact of turnover-induced pay losses due to forfeiture of past compensation and reductions in future earnings opportunities suggests that one should expect CEOs to be compensated with about 2-3 percent in terms of total pay for a one percentage point increase in turnover risk. Of course, these estimates merely account for the potential monetary sanctions of forced turnover. Other personal implications such as loss of seniority or reputation are likely to impose additional costs on CEOs. Estimating the total turnover risk premium is the task of the empirical analysis.

3.4 The empirical relationship between turnover risk and executive compensation

The discussion in the previous section indicates that turnover can imply an economically significant cost for CEOs. If compensation contracts need to obey a participation constraint, this suggests that increased turnover risk should go hand in hand with increased levels of executive compensation, both in the time series and in the cross section. In this section, we test this prediction. We begin by describing the data. We then turn to the estimation of hazard rates for CEOs, which are the key explanatory variable in our compensation regressions. Then we present our primary results. Finally, we investigate the causality issue in the turnover risk - compensation relation.

3.4.1 Data

We use the Jenter and Kanaan (2006) database on CEO turnover which covers the period 1993 to 2001. In terms of numbers of companies covered, the Jenter and Kanaan database is the most extensive source on CEO turnover available to date, covering the entire ExecuComp universe of firms from 1993 to 2001.[7] From 1993 on ExecuComp covers nearly all S&P1500 companies. The Jenter and Kanaan data includes 1,590 CEO turnovers of which 384 are classified as forced. We merge the Jenter and Kanaan data on CEO turnover with ExecuComp from which we obtain compensation and some basic balance sheet data, and with the CRSP database from which we obtain stock returns and volatilities. To obtain a set of corporate governance variables we then merge the resulting sample with the IRRC directors database. The final sample used in the main compensation regressions has 10,216 CEO-year observations with non-missing data on compensation, balance-sheet variables, stock returns and volatilities. Since IRRC data is available only starting in 1996, regressions including corporate governance variables and CEO characteristics are based on 5,803 CEO-year observations. While our results are robust to the inclusion of all observations with complete data, for our main analysis we exclude CEO-year observations with total compensation in the top and bottom percentile to reduce outlier problems. We also restrict to non-owner CEOs, which we define as CEOs with ownership stakes below 10%. This excludes about 10% of CEO-years in our sample. The reason is that the hazard rates we estimate below are unlikely to hold for owner-CEOs as these executives are virtually

[7] Unfortunately, detailed turnover data is not yet available to us beyond 2001, but acquiring this data is part of our ongoing efforts.

never fired.[8] Descriptive statistics are given in Table 3.2.

3.4.2 Estimating turnover risk

Our initial motivation for this study was based on the stylized fact that average CEO pay and turnover frequencies are correlated over time (see Section 3.2). In order to extend our analysis of the empirical relationship between turnover risk and compensation to the cross section, we need a turnover measure that varies across CEOs. We use a Probit model to estimate empirical hazard rates. Predicted values from a Probit model are equivalent to hazard rates, as they implicitly condition on the CEO being in office in year $t-1$. In the next subsection we demonstrate this equivalence formally. We then proceed to describe and justify the determinants of the exogenous hazard rate and present our estimation results.

A Probit model for the hazard rate. We begin by briefly outlining our empirical approach to modeling the turnover hazard rate. Let T_F denote the time of forced CEO turnover. The hazard rate, $h(t)$, can be interpreted as the instantaneous probability (per time unit) that the CEO is fired, conditional on his survival up to time t. It is defined as

$$\begin{aligned} h(t) &= \lim_{\Delta t \to 0} \frac{1}{\Delta t} P[t < T_F \leq t + \Delta t | T_F > t] \\ &= \lim_{\Delta t \to 0} \frac{1}{\Delta t} \frac{P[t < T_F \leq t + \Delta t]}{P[T_F > t]} = \frac{f(t)}{1 - F(t)} \end{aligned} \tag{3.12}$$

It is constant and equal to λ for the exponential distribution function. Less formally, $h(t)\Delta t$ gives the probability that a CEO is fired during the period Δt given he is in office at time t.

To obtain CEO-specific hazard rates we use the predicted values from a Probit regression model, where the dependent variable is the turnover dummy. The turnover dummy, D_{it}, where i denotes the company and t the year, is defined as follows: it takes the value of one if the CEO of firm i is no longer in office at the end of fiscal year $t+1$, conditional on being in office at the end of fiscal year t. It is zero if he remains in office throughout fiscal year $t+1$. Thus, just as the hazard rate, the turnover indicator conditions on the CEO's survival up to time t. The Probit model can then be stated as

$$E[D_{it}|x_{it}] = P[D_{it} = 1|x_{it}] = P[t < T_F \leq t + 1 | T_F > t, x_{it}] = \Phi(\beta' x_{it}) \tag{3.13}$$

[8] Only one CEO with an ownership stake of above 10% is classified as fired in the Jenter-Kanaan sample.

Table 3.2: Descriptive Statistics. The table displays descriptive statistics for the ExecuComp sample of firms from 1993 to 2001. Panel A contains turnover statistics from (Jenter and Kanaan, 2006). Panel B contains basic firm characteristics. Panel C contains CEO compensation variables. The numbers in brackets refer to the the subsample which excludes the top and bottom 1% of total compensation as well as CEOs with an ownership stake above 10%. Corporate governance variables are given in Panel D and are from IRRC. The sample size for the corporate governance variables is smaller than that of compensation and firm characteristics since IRRC records start only in 1996.

PANEL A: Frequency of Forced and Voluntary Turnover

# Firm years	# Forced Turnovers	#Voluntary Turnovers	% of Firms with >= 1 Turnovers per Year	% of Firms with >= 1 Forced Turnovers per Year	% of Firms with >= 1 Voluntary Turnovers per Year
15798	384	1206	9.47%	2.36%	7.47%

PANEL B: Firm Characteristics

	Mean	Median	Std	N
Sales ($m)	3860	1044	10518	13596
Total Assets($m)	8981	1225	37239	13596
ROA(%)	2.90	4.17	17.67	13596
Volatility(%)	39.61	34.80	20.55	13596

PANEL C: CEO Compensation Characteristics

	Mean	Median	Std	N
Total Compensation($1000)	4607	2044	13758	11619
	[3838]	[2148]	[4801]	[10216]
Salary($1000)	637	581	341	11669
	[645]	[593]	[326]	[10253]
Bonus($1000)	676	347	1730	11669
	[646]	[366]	[1052]	[10253]
BSM Option Value($1000)	2510	566	11110	11619
	[1883]	[625]	[3576]	[10213]
Value of Restricted Stock($1000)	368	0	6556	11669
	[278]	[0]	[1120]	[10253]
Other Compensation($1000)	414	54	1839	11669
	[383]	[58]	[1161]	[10253]
Percentage of Equity-based Pay	38	37	29	11595
	[39]	[39]	[29]	[10213]

PANEL D: Corporate Governance Variables

	Mean	Median	Std	N
Board size	9.82	9	3.17	7513
CEO is Chairman	0.64	1	0.48	7513
Percentage of Independent Directors	62.19	64.29	18.31	7513

where x_{it} is a vector of explanatory variables, β is the coefficient vector, and Φ denotes the normal probability distribution function. Predicted values of this regression are estimates of 1-year firing probabilities conditional on survival up to year t:

$$\hat{h}^{1yr}(t) = E[D_{it}|x_{it}, \hat{\beta}] = 0 \cdot (1 - \Phi(\hat{\beta}' x_{it})) + 1 \cdot \Phi(\hat{\beta}' x_{it}) = \Phi(\hat{\beta}' x_{it}) \tag{3.14}$$

This is formally equivalent to the theoretical 1-year firing probability given by

$$h^{1yr}(t) = P[t < T_F \leq t + 1 | T_F > t] = \frac{\int_t^{t+1} f(t)dt}{1 - F(t)} = 1 - e^{-\lambda} \xrightarrow[\lambda \to 0]{} \lambda \tag{3.15}$$

To obtain the instantaneous, predicted hazard rate, $\hat{\lambda}$, we transform the fitted values from the Probit regression into $\hat{\lambda} = -\log(1 - \hat{h}^{1yr}(t))$.

Determinants of the exogenous hazard rate. In estimating hazard rates empirically we explicitly account for the potential endogeneity of turnover risk to CEO skill. Endogeneity bias arises when turnover risk is correlated with CEO skill, which, at the same time, determines compensation. More specifically, if CEO skill is negatively correlated with the turnover probability and positively correlated with compensation, the estimated effect of the hazard rate on CEO pay will be biased downward.

To control for this type of endogeneity we instrument the hazard rate with variables unrelated to CEO skill. We use two specifications to estimate exogenous hazard rates. In Model 1 we use industry and year dummies only. In Model 2 we also include industry performance. This is motivated by the recent literature on CEO turnover which suggests that industry-induced performance is a significant determinant of turnover.

Note that we deviate from the existing literature on executive turnover which largely focuses on relative performance sensitivity (Huson et al., 2001; Jenter and Kanaan, 2006; Kaplan and Minton, 2006). These studies are interested in the sensitivity of both idiosyncratic and industry- or market-induced performance on turnover probabilities. In this study we explicitly exclude idiosyncratic performance from the Probit regression specification. This is because hazard rates predicted by idiosyncratic performance would inversely proxy for CEO skill. Such hazard rates should be less positively related to CEO pay, because the relation would pick up both the compensation for exogenous turnover risk and the penalty due to poor skill. On the other hand, hazard rates predicted by exogenous factors only, such as industry group affiliation or industry performance, would indeed justify high pay as they represent an a priori greater risk exposure of the CEO.

Estimated hazard rates. Table 3.3 presents the results for the Probit regressions. The results for model 1, which uses industry and year dummies only, show that the Finance sector exhibits the lowest firing probability, followed by the Utilities and the Manufacturing & Energy sectors while turnover risk is highest in the High Tech sector. Interestingly, the High Tech sector is also the one with the highest average CEO compensation over the sample period while in the Utilities sector CEO pay is the lowest. (We conduct the main analysis including all sectors, but the results are robust to the exclusion of utilities and financials.)

The results from Model 2, which adds current-year and lagged industry returns, show a significant relation between forced turnover and industry performance suggesting that boards do not completely filter out industry-induced performance in their firing decision. As pointed out before, we explicitly omit idiosyncratic performance in the Probit regressions in order to obtain hazard rates which are unrelated to CEO skill. Even though idiosyncratic performance is highly significant in this regression, omission does not bias the coefficient estimates of the other regressors as idiosyncratic performance is, by definition, orthogonal to industry performance, industry and year dummies.

Table 3.4 illustrates the distributions of the predicted hazard rates across the sample years. The variation in hazard rates across industries is quite substantial. For instance, when using model 1, in 2000 CEOs in the High Tech sector were subject to a hazard rate of 6.35% while only 1.93% of CEOs in the Utilities and Finance sectors were fired. As shown in Panel B, the spread between the 5% and 95% quantile is even larger when industry performance is added to the Probit specification.

The large cross-sectional variation of hazard rates evident from Table 3.4 provides a strong source of identification and thus allows us to examine the link between turnover risk and compensation in a cross sectional and panel setting.

3.4.3 Turnover risk and compensation

Main Results. Table 3.5 presents our primary empirical results. The results first indicate that the basic control variables have the expected signs: Current and lagged stock return is positively correlated with pay, CEOs of larger firms earn more, and compensation is higher when volatility is higher.

The key result for our purposes is that the predicted hazard rate for CEOs is strongly positively correlated with total compensation: The results suggest that a one percentage point increase in the hazard rate is associated with about 10% more in terms of total com-

Table 3.3: Probit regressions of forced CEO turnover. This table displays Probit regressions estimating the probability of forced turnover. The table reports the marginal probabilities expressed in percent. Industry dummies are defined according to the Fama/French industry classification for five industry groups, extended to include Finance and Utilities as separate groups. The omitted industry is "Cnsmr: Consumer Durables, NonDurables, Wholesale, Retail, and Some Services (Laundries, Repair Shops)". Industry returns are median returns of the corresponding industry group according to the (Fama and French, 1997) classification, and are expressed as decimals. P-values, reported in parentheses, are calculated with robust standard errors clustered at the industry level. *, **, and *** denote significance at the 10%, 5%, and 1% level,respectively.

	Model 1	Model 2
Industry return in year t		-1.58***
		(0.000)
Industry return in year t-1		-3.17***
		(0.000)
Manufacturing & Energy	-1.00***	-0.75***
	(0.000)	(0.002)
High Tech	1.04***	1.41***
	(0.000)	(0.000)
Health	0.12	0.10
	(0.000)	(0.000)
Finance	-1.64***	-1.14***
	(0.000)	(0.000)
Utilities	-1.14***	-0.76***
	(0.000)	(0.000)
Other	-0.20	-0.12
	(0.000)	(0.001)
Year Dummies	Yes	Yes
N	14,818	14,818

pensation. In dollar values this corresponds to around $200,000 more risk-neutrally valued pay for the median CEO, and to around $400,000 for CEOs receiving mean compensation. Note that the hazard rate is highly significant even after controlling for firm size as measured by the log of market capitalization. This is an important result as it shows that our estimates do not pick up spurious relations due to the correlation between turnover risk and market values. Importantly, the relation holds when controlling for common year effects. As the year dummies pick up the common variation of turnover risk and compensation over time, this result indicates that there is an additional cross-sectional relation between the two variables. We explore the time-series and cross-sectional relations separately below.

Table 3.4: Distribution of predicted hazard rates. Hazard rates are estimated using the predicted values of the Probit regressions in Table 3.3 and expressed in percent.

PANEL A: Model 1

Year	Q5	Q25	Q50	Q75	Q95	Mean	Q95-Q5
1993	0.63	1.04	1.58	1.74	2.60	1.46	1.97
1994	0.90	1.46	2.18	2.38	3.49	2.04	2.59
1995	0.95	1.54	2.28	2.49	3.64	2.16	2.70
1996	1.07	1.73	2.55	2.78	4.03	2.42	2.96
1997	1.43	2.26	3.28	3.74	5.09	3.17	3.66
1998	1.23	1.96	2.87	3.27	4.50	2.79	3.27
1999	1.38	2.19	3.46	3.63	4.95	3.18	3.57
2000	1.93	2.99	4.62	4.83	6.48	4.21	4.55
2001	0.68	1.13	1.87	1.97	2.79	1.71	2.10
All years	0.95	1.71	2.38	3.46	4.95	2.64	4.01

PANEL B: Model 2

Year	Q5	Q25	Q50	Q75	Q95	Mean	Q95-Q5
1993	0.32	0.97	1.19	1.95	3.04	1.47	2.72
1994	0.71	1.37	1.73	2.59	4.01	2.03	3.29
1995	0.84	1.50	2.07	2.88	3.63	2.16	2.79
1996	0.83	1.54	2.34	3.37	4.12	2.42	3.29
1997	1.00	1.91	2.97	4.02	5.90	3.17	4.91
1998	0.79	1.88	2.49	3.69	5.09	2.82	4.30
1999	1.78	2.40	3.21	3.67	4.71	3.15	2.93
2000	2.39	3.18	4.04	5.07	7.37	4.17	4.98
2001	0.42	0.81	1.18	2.41	5.23	1.74	4.81
All years	0.79	1.50	2.48	3.39	5.40	2.64	4.61

Columns (2) and (4) add corporate governance variables and CEO characteristics. (The sample size is reduced because the IRRC data are available only starting in 1996.) Chairman-CEOs earn nearly 20% more than non-chairman CEOs. Board size is negatively related to CEO pay while the coefficient of the percentage of independent directors has a positive sign.[9] CEO age and tenure are not significantly related to compensation. Importantly, the result for the impact of the hazard rate remains strong and economically and statistically significant even when controlling for these additional variables.

Time-series and cross-sectional relations. This subsection aims at disentangling the time-series and cross-sectional elements of the turnover-compensation relation. We start

[9] One reason for the latter result may be that benchmarking to high pay levels is more prevalent in corporations with a greater fraction of outside directors. Alternatively, independent boards set more high powered incentives and, therefore, need to give CEOs greater risk-neutral compensation to satisfy their participation constraint. This is consistent with the theoretical prediction of Hermalin (2005) that stronger boards may, in fact, be associated with higher executive pay.

Table 3.5: OLS regressions for log of total compensation. The table reports ordinary least squares (OLS) regressions of log of total compensation on the hazard rate and control variables for S&P1500 CEOs over the period 1993-2001. The hazard rate is estimated as the predicted value from the Probit regressions in Table 3.3 using model 1 for regressions 1 and 2, and model 2 for regressions 3 and 4. Stock return, stock return volatility, and the hazard rate are expressed in percent. Market value is computed as the market value of equity plus the book value of debt. Volatility and log market value are measured in t-1. Chairman is a dummy variable which equals one if the CEO is chairman of the board and zero otherwise. Board size is the number of directors on the board. Independent directors is the percentage of independent directors on the board, expressed in percent. Age and tenure are the CEO's age and tenure, respectively. The dependent variable, total compensation, includes salary, bonus, restricted stock granted and the Black-Scholes value of option grants. It is truncated at the 1% level to reduce outlier problems. Nominal values are converted to 2000 dollars using the consumer price index provided by the U.S. Bureau of Labor Statistics. Observations with CEO ownership 10% are also excluded. P-values are calculated with robust standard errors clustered at the CEO-firm level, and are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Model 1		Model 2	
Dependent Variable	Ln(Total Comp) (1)	Ln(Total Comp) (2)	Ln(Total Comp) (3)	Ln(Total Comp) (4)
Hazard rate	0.1238*** (0.000)	0.1169*** (0.000)	0.0919*** (0.000)	0.0802*** (0.000)
Return in t	0.0017*** (0.000)	0.0015*** (0.005)	0.0018*** (0.000)	0.0016*** (0.003)
Return in t-1	0.0009*** (0.000)	0.0009*** (0.000)	0.0013*** (0.000)	0.0012*** (0.000)
Ln(Market value)	0.4282*** (0.000)	0.4467*** (0.000)	0.4262*** (0.000)	0.4466*** (0.000)
Volatility	0.0081*** (0.000)	0.0084*** (0.000)	0.0083*** (0.000)	0.0086*** (0.000)
Chairman		0.1823*** (0.000)		0.1785*** (0.000)
Board size		-0.0117* (0.055)		-0.0139** (0.023)
Indept. directors [%]		0.0016* (0.065)		0.0015* (0.075)
Age		-0.0019 (0.447)		-0.0017 (0.484)
Tenure		-0.0016 (0.571)		-0.0014 (0.612)
Year dummies	Yes	Yes	Yes	Yes
Observations	10205	5835	10205	5835
Adjusted R-squared	0.467	0.481	0.465	0.478

by separating the time-series effects in a regression using CEO-firm fixed effects. In this specification, identification depends only on time-series variation of the hazard rate for a given CEO-firm combination. Notice that, as companies rarely change industry over time, variation in the hazard rate of Model 1 comes from the within-industry time-series variation of the hazard rate only, while Model 2 also generates variation due to changes in industry performance. For this reason we do not use year dummies as additional controls, because they would leave no or little additional co-variation between the hazard rate and compensation.

Table 3.6 contains the results of the fixed effects regressions. The hazard rate enters positively in all regressions and is always significant. Notice that the hazard rate coefficient is lower by about one half if the extended Probit specification is used to estimate the hazard rate. One explanation for this finding is that in this case the hazard is by construction negatively correlated with industry and hence total stock returns. This may introduce a mechanical relation between the hazard rate and (the equity-based part of) total compensation even if total stock returns are controlled for.

An important aspect of these results is that even with time-series identification only, and even when controlling for market value, the hazard rate coefficient remains positive and highly significant. Recall that market capitalization exhibits a similar non-monotonic time-series pattern as the hazard rate and total compensation. The results of Table 3.6 thus show that market valuations cannot alone explain the time-series evolution of CEO pay and that the hazard rate has additional explanatory power.

In order to isolate the pure cross-sectional component of the turnover effect, we estimate cross-sectional regressions by averaging all annual observations of a CEO in a given firm. The results shown in Table 3.7 corroborate our previous findings. The magnitude of the coefficients relative to those obtained in the fixed effects regressions indicates that the cross-sectional element is even more important in the overall relation between turnover risk and compensation than the time-series element.

CEO tenure and the turnover premium. Our results so far have shown that CEOs who are exogenously exposed to higher turnover risk also receive higher compensation, irrespective of their tenure. If it is true that a turnover premium on compensation is the result of explicit or implicit bargaining, then we would expect the results to be stronger at times when pay is actually negotiated. This is obviously the case when the CEO is newly hired while it is less clear in later years of the CEO's tenure. Table 3.8 reports regression results for the subsample of CEOs who are in the first year of their tenure. Table 3.9

Table 3.6: Fixed effects regressions for log total compensation. The table reports CEO-firm fixed effects regressions of log of total compensation on the hazard rate and control variables for S&P1500 CEOs over the period 1993-2001. The hazard rate is estimated as the predicted value from the Probit regressions in Table 3.3 using model 1 for regressions 1 and 2, and model 2 for regressions 3 and 4. Stock return, stock return volatility, and the hazard rate are expressed in percent. Market value is computed as the market value of equity plus the book value of debt. Volatility and log market value are measured in t-1. Chairman is a dummy variable which equals one if the CEO is chairman of the board and zero otherwise. Board size is the number of directors on the board. Independent directors is the percentage of independent directors on the board, expressed in percent. Age and tenure are the CEO's age and tenure, respectively. The dependent variable, total compensation, includes salary, bonus, restricted stock granted and the Black-Scholes value of option grants. It is truncated at the 1% level to reduce outlier problems. Nominal values are converted to 2000 dollars using the consumer price index provided by the U.S. Bureau of Labor Statistics. Observations with CEO ownership 10% are also excluded. P-values are calculated with robust standard errors clustered at the CEO-firm level, and are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Model 1		Model 2	
Dependent Variable	Ln(Total Comp)	Ln(Total Comp)	Ln(Total Comp)	Ln(Total Comp)
	(1)	(2)	(3)	(4)
Hazard rate	0.0605***	0.0366***	0.0345***	0.0151*
	(0.000)	(0.002)	(0.000)	(0.088)
Return in t	0.0016***	0.0010*	0.0017***	0.0010*
	(0.001)	(0.067)	(0.001)	(0.064)
Return in t-1	0.0008***	0.0010***	0.0010***	0.0011***
	(0.000)	(0.000)	(0.000)	(0.000)
Ln(Market value)	0.4824***	0.2750***	0.4934***	0.2776***
	(0.000)	(0.000)	(0.000)	(0.000)
Volatility	0.0027***	-0.0039*	0.0022**	-0.0048**
	(0.008)	(0.076)	(0.019)	(0.025)
Chairman		0.0485		0.0461
		(0.166)		(0.191)
Board size		0.0034		0.0030
		(0.641)		(0.686)
Indept. directors [%]		-0.0001		-0.0001
		(0.949)		(0.922)
Age		-0.0503***		-0.0510***
		(0.000)		(0.000)
Tenure		0.1215***		0.1233***
		(0.000)		(0.000)
CEO-Firm fixed effects	Yes	Yes	Yes	Yes
Observations	10205	5835	10205	5835
Adjusted R-squared	0.146	0.109	0.143	0.107

Table 3.7: Cross-sectional regressions for log total compensation. The table reports cross-sectional (between effects) regressions of log of total compensation on the hazard rate and control variables for S&P1500 CEOs over the period 1993-2001. The hazard rate is estimated as the predicted value from the Probit regressions in Table 3.3 using model 1 for regressions 1 and 2, and model 2 for regressions 3 and 4. Stock return, stock return volatility, and the hazard rate are expressed in percent. Market value is computed as the market value of equity plus the book value of debt. Volatility and log market value are measured in t-1. Chairman is a dummy variable which equals one if the CEO is chairman of the board and zero otherwise. Board size is the number of directors on the board. Independent directors is the percentage of independent directors on the board, expressed in percent. Age and tenure are the CEO's age and tenure, respectively. The dependent variable, total compensation, includes salary, bonus, restricted stock granted and the Black-Scholes value of option grants. It is truncated at the 1% level to reduce outlier problems. Nominal values are converted to 2000 dollars using the consumer price index provided by the U.S. Bureau of Labor Statistics. Observations with CEO ownership 10% are also excluded. P-values are calculated with robust standard errors clustered at the CEO-firm level, and are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Model 1		Model 2	
Dependent Variable	Ln(Total Comp) (1)	Ln(Total Comp) (2)	Ln(Total Comp) (3)	Ln(Total Comp) (4)
Hazard rate	0.1139*** (0.000)	0.1005*** (0.000)	0.1027*** (0.000)	0.0831*** (0.000)
Return in t	0.0021*** (0.000)	0.0023*** (0.000)	0.0021*** (0.000)	0.0023*** (0.000)
Return in t-1	0.0005** (0.034)	0.0006** (0.045)	0.0008*** (0.000)	0.0009*** (0.003)
Ln(Market value)	0.4432*** (0.000)	0.4540*** (0.000)	0.4412*** (0.000)	0.4517*** (0.000)
Volatility	0.0089*** (0.000)	0.0082*** (0.000)	0.0085*** (0.000)	0.0078*** (0.000)
Chairman		0.1668*** (0.000)		0.1628*** (0.000)
Board size		-0.0178** (0.011)		-0.0181** (0.010)
Indept. directors [%]		0.0017* (0.067)		0.0018* (0.057)
Age		-0.0051** (0.037)		-0.0047* (0.053)
Tenure		-0.0022 (0.446)		-0.0023 (0.422)
Observations	10205	5835	10205	5835
Adjusted R-squared	0.490	0.502	0.490	0.501

contains the results for the complementary subsample of CEOs beyond their first year of tenure. As expected, the turnover-compensation relation is much stronger for first year CEOs than for more senior CEOs. The coefficient estimates of the hazard rate are about twice as large for first year CEOs compared to more senior CEOs. For the median CEO this corresponds to around \$400,000 more in terms of total compensation for a one percentage point increase in turnover risk, and around \$800,000 more for the mean CEO.

Interestingly, Tables 3.8 and 3.9 also reveal that newly hired CEOs are not rewarded for past performance, i.e. performance that can only be attributed to their predecessors. In contrast, more senior CEOs are indeed rewarded for past performance. To our knowledge, we are the first to document this fact.

Robustness. The results are robust to a large variety of alternative specifications and subsamples. For space reasons, we only point out that the results continue to hold (1) if we exclude financials and utilities, (2) if we include CEOs in the top and bottom percentile of total compensation, (3) if we include additional corporate governance variables such as the Gompers et al. (2003) governance index, the percentage of independent directors and board size in the estimation of CEO hazard rates. If (4) we include CEOs with ownership stakes above 10%, the hazard rate coefficients generally become less significant but remain significant at the 5% level in all regressions except for those in Table 3.5, columns (1) and (3), where they are borderline significant.

3.4.4 Causality

The argument that efficient executive compensation should rise in response to higher turnover risk is intuitively appealing. In addition, the data also allow us to address explicitly a potential concern with our empirical results in the previous section, namely, that the hazard rate coefficient may only in part reflect the causal effect of turnover risk on compensation. At least two other explanations are conceivable. First, the positive correlation between turnover risk and compensation may be driven by reverse causation. One may argue that high CEO pay increases firing risk as it leads to higher performance expectations and accountability of CEOs. Second, there may be an omitted, possibly unobservable factor driving both turnover risk and compensation. The primary candidate for this factor could be a general tendency towards stronger incentives which may lead boards to grant pay packages with higher proportions of equity-based pay, and, at the same time, to be

Table 3.8: OLS regressions of log total compensation for first year CEOs. The table reports ordinary least squares (OLS) regressions of log of total compensation on the hazard rate and control variables for S&P1500 CEOs in the first year of their tenure. The sample period is 1993-2001. The hazard rate is estimated as the predicted value from the Probit regressions in Table 3.3 using model 1 for regressions 1 and 2, and model 2 for regressions 3 and 4. Stock return, stock return volatility, and the hazard rate are expressed in percent. Market value is computed as the market value of equity plus the book value of debt. Volatility and log market value are measured in t-1. Chairman is a dummy variable which equals one if the CEO is chairman of the board and zero otherwise. Board size is the number of directors on the board. Independent directors is the percentage of independent directors on the board, expressed in percent. Age and tenure are the CEO's age and tenure, respectively. The dependent variable, total compensation, includes salary, bonus, restricted stock granted and the Black-Scholes value of option grants. It is truncated at the 1% level to reduce outlier problems. Nominal values are converted to 2000 dollars using the consumer price index provided by the U.S. Bureau of Labor Statistics. Observations with CEO ownership 10% are also excluded. P-values are calculated with robust standard errors clustered at the CEO-firm level, and are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Model 1		Model 2	
Dependent Variable	Ln(Total Comp)	Ln(Total Comp)	Ln(Total Comp)	Ln(Total Comp)
	(1)	(2)	(3)	(4)
Hazard rate	0.2293***	0.2273***	0.1720***	0.1578***
	(0.000)	(0.000)	(0.000)	(0.000)
Return in t	0.0015***	0.0013**	0.0018***	0.0015**
	(0.000)	(0.027)	(0.000)	(0.010)
Return in t-1	-0.0009	-0.0009	-0.0001	-0.0001
	(0.173)	(0.297)	(0.938)	(0.954)
Ln(Market value)	0.4660***	0.5002***	0.4594***	0.4931***
	(0.000)	(0.000)	(0.000)	(0.000)
Volatility	0.0084***	0.0078***	0.0089***	0.0089***
	(0.000)	(0.003)	(0.000)	(0.001)
Chairman		0.0413		0.0266
		(0.583)		(0.727)
Board size		-0.0277**		-0.0288**
		(0.047)		(0.039)
Indept. directors [%]		0.0059***		0.0060***
		(0.004)		(0.003)
Age		-0.0131***		-0.0122**
		(0.009)		(0.019)
Observations	1075	699	1075	699
Adjusted R-squared	0.472	0.485	0.466	0.473

more willing to fire CEOs.[10] As more incentive compensation is associated with higher ex-

[10]Note that the fact that monetary incentives and turnover as an incentive device can be substitutes is perfectly compatible with the notion that as boards wish to implement stronger incentives overall, they

Table 3.9: OLS regressions of log total compensation for CEOs beyond the first year of their tenure. The table reports ordinary least squares (OLS) regressions of log of total compensation on the hazard rate and control variables for S&P1500 CEOs beyond the first year of their tenure. The sample period is 1993-2001. The hazard rate is estimated as the predicted value from the Probit regressions in Table 3.3 using model 1 for regressions 1 and 2, and model 2 for regressions 3 and 4. Stock return, stock return volatility, and the hazard rate are expressed in percent. Market value is computed as the market value of equity plus the book value of debt. Volatility and log market value are measured in t-1. Chairman is a dummy variable which equals one if the CEO is chairman of the board and zero otherwise. Board size is the number of directors on the board. Independent directors is the percentage of independent directors on the board, expressed in percent. Age and tenure are the CEO's age and tenure, respectively. The dependent variable, total compensation, includes salary, bonus, restricted stock granted and the Black-Scholes value of option grants. It is truncated at the 1% level to reduce outlier problems. Nominal values are converted to 2000 dollars using the consumer price index provided by the U.S. Bureau of Labor Statistics. Observations with CEO ownership 10% are also excluded. P-values are calculated with robust standard errors clustered at the CEO-firm level, and are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Model 1		Model 2	
Dependent Variable	Ln(Total Comp) (1)	Ln(Total Comp) (2)	Ln(Total Comp) (3)	Ln(Total Comp) (4)
Hazard rate	0.1127***	0.1018***	0.0826***	0.0733***
	(0.000)	(0.000)	(0.000)	(0.000)
Return in t	0.0017***	0.0015***	0.0018***	0.0016***
	(0.000)	(0.007)	(0.000)	(0.005)
Return in t-1	0.0011***	0.0011***	0.0014***	0.0014***
	(0.000)	(0.000)	(0.000)	(0.000)
Ln(Market value)	0.4242***	0.4427***	0.4224***	0.4428***
	(0.000)	(0.000)	(0.000)	(0.000)
Volatility	0.0079***	0.0082***	0.0081***	0.0083***
	(0.000)	(0.000)	(0.000)	(0.000)
Chairman		0.2186***		0.2181***
		(0.000)		(0.000)
Board size		-0.0136**		-0.0157**
		(0.024)		(0.010)
Indept. directors [%]		0.0012		0.0011
		(0.175)		(0.197)
Age		-0.0024		-0.0021
		(0.291)		(0.349)
Observations	9130	5584	9130	5584
Adjusted R-squared	0.469	0.483	0.466	0.481

pected values of pay, this mechanism may cause turnover risk and levels of compensation to be correlated.

make more use of both tools.

In this section we address both of these alternative interpretations. The key idea of our approach to investigate the causality issue is that the cause must occur *before* the effect. The methodology thus relies on the time-series pattern of turnover and compensation.[11] In particular, we consider two sets of arguments. First, if higher compensation increases turnover risk, we would expect that compensation is particularly high before a forced turnover. Conversely, if it is true that turnover risk causally affects compensation through a turnover risk premium, we would expect that compensation increases following a forced turnover as agents will revise their perception of turnover risk upward when forced turnover occurs. Second, if forced turnover and higher compensation are both a consequence of a trend towards stronger incentives, we would expect the fraction of equity-based pay to increase hand in hand with total compensation in firms where forced turnover occurs. This is because a risk-averse CEO would get higher expected levels of pay when the power of incentives increases. Conversely, if equity-based pay is lower after forced turnover, but we still observe higher total compensation, this rules out the explanation that a general trend toward stronger incentives affects compensation and turnover risk simultaneously.

We first investigate the potential reverse causality in the turnover risk - compensation relation. We use voluntary turnovers as a benchmark and compare the evolution of CEO compensation around turnovers of the two distinct types. To do this, we use the following regression model:

$$Y_{it} = \sum_{\tau=-\underline{T}}^{\overline{T}} \pi_\tau^F F_{i\tau} + \sum_{\tau=-\underline{T}}^{\overline{T}} \pi_\tau^V V_{i\tau} + \beta' X_{it} + \epsilon_{it} \tag{3.16}$$

The dependent variable Y is the log of total CEO compensation. The indices i and t reference the firm and the fiscal year, respectively. The index τ denotes the year relative to the year of turnover. More precisely, τ is normalized such that $\tau = 0$ is the last fiscal year the incumbent CEO is in office, so that $\tau < 0$ indicates the $-\tau^{\text{th}}$ year before turnover and $\tau > 0$ indicates the τ^{th} year after turnover. X_{it} is a vector of control variables.

The key variables are the $F_{i\tau}$ and $V_{i\tau}$ indicator variables. $F_{i\tau}$ equals one if forced turnover occurs in firm i at $-\tau$ years from the current year t, and zero otherwise. $V_{i\tau}$ is defined analogously for firms in which turnover occurs voluntarily.

The vectors π_τ^F and π_τ^V are the parameters of interest in this equation. They measure

[11] In drawing conclusions about causality from the time-series relation of variables, our method is closely related to the concept of Granger causality. A variable X_t is said to "Granger cause" the variable Y_{t+1} if (a) X_t occurs before Y_{t+1}; and (b) it contains information useful in forecasting Y_{t+1} that is not found in a group of other appropriate variables.

the period-specific means of total compensation in firms where CEO turnover is forced and voluntary, respectively, conditional on all covariates. By including a pair of indicator variables, (π_τ^F, π_τ^V), for each period, the relation between turnover type and compensation is allowed to vary with τ. The coefficient difference $\pi_\tau^F - \pi_\tau^V$ can be interpreted as the percentage point difference in CEO compensation between firms where turnover is forced and firms where turnover is voluntary, for a given period τ, and controlling for other determinants of CEO pay. For example, a coefficient difference $\pi_{-3}^F - \pi_{-3}^V = .05$ means that three years before the turnover, CEOs who are dismissed earn 5 percentage points more than CEOs that depart voluntarily. The time series of the coefficient differences $\pi_\tau^F - \pi_\tau^V$ around turnover potentially allows us to detect causal effects of forced departure on compensation. If these differences were significantly positive before turnover, reverse causality would indeed be a concern.

Figure 3.7 illustrates the results. The solid lines plot the point estimates of the coefficient differences, $\pi_\tau^F - \pi_\tau^V$, by period, as obtained from equation (3.16). The dashed lines indicate 90% confidence intervals around zero (they are curved because of the varying number of observations at different time horizons). (The detailed regression results including significance tests for the differences of coefficients are given in Table 3.12 which is relegated to the appendix.) Panel A displays the regression estimates using the basic set of firm-specific control variables we also used in the hazard rate regressions. Panel B shows the results when corporate governance variables are added as controls. Recall that in the regressions of the previous section hazard rates are determined entirely by year and industry. Here, by contrast, we use the actual occurrence of turnover as a proxy for the increased perception of turnover risk and control for industry and year effects. Hence, the results of the two regression approaches can be seen as complementary since turnover risk is driven by distinct sources.

The two panels of Figure 3.7 suggest that in the years preceding turnover, CEO compensation does not differ systematically between firms that experience forced and voluntary turnovers. The point estimates for the pre-turnover period are both positive and negative and, with two exceptions, lie well within the confidence bounds. In contrast, in the years following turnover, CEO compensation appears to be significantly higher in firms experiencing forced turnovers relative to their otherwise similar counterparts. All point estimates are positive and many lie above the upper confidence bound.

To confirm this result statistically, we define a coarser set of indicator variables, F_{i-}, V_{i-}, F_{i+}, V_{i+}, where the subscripts "-" and "+" indicate the entire pre- and post-turnover

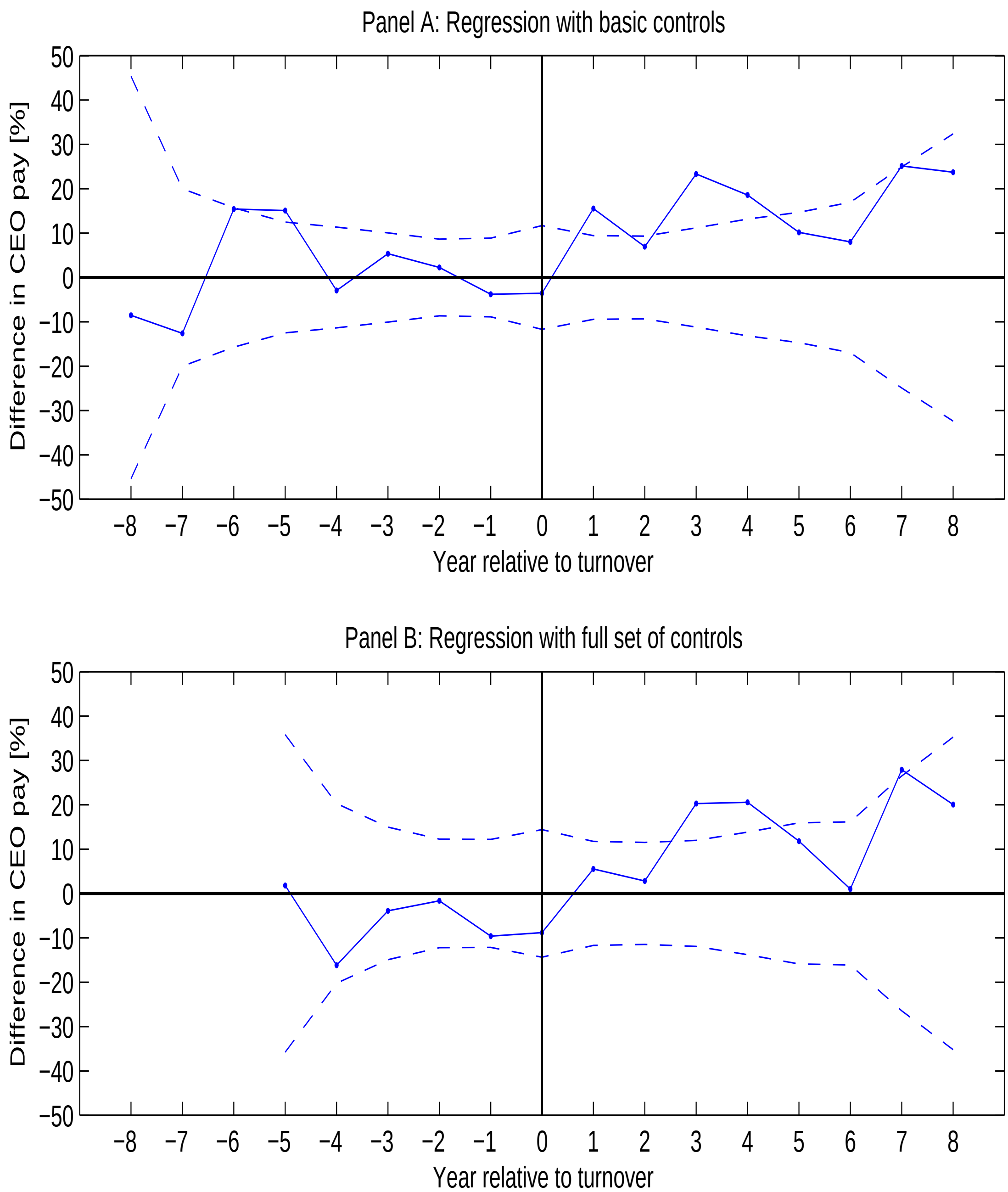

Figure 3.7: Percentage difference in total compensation. The figure shows the percentage difference in total compensation between CEOs in firms where turnover is forced and firms where turnover is voluntary. The solid line plots the point estimates of the coefficient differences $\pi_\tau^F - \pi_\tau^V$ by period. The dashed lines represent 90% confidence intervals of a two-sided Wald test that the coeffiient differences are equal to zero. Year zero refers to the last fiscal year the incumbent CEO is in office.

period, respectively. Then we run the same regressions as before but replace the period-specific indicators by the pre- and post turnover indicators. Columns (1) and (2) of Table 3.10 show the results. As expected, CEO compensation does not differ significantly by departure type in the pre-turnover period. In the post-turnover period, however, CEOs following dismissed predecessors earn between 11 and 15 percentage points more than CEOs who replace voluntarily departed CEOs. The difference-in-differences tests reported below the simple difference tests further underscore that forced turnover brings about a significant shift in CEO pay relative to voluntary departures. The occurrence of forced turnover shifts CEO compensation in these firms upward by 13 to 19 percentage points relative to firms where the CEO departed voluntarily. This clearly rejects the reverse causation hypothesis and provides additional support for the executive turnover risk premium.

Table 3.10: Event time regressions of log total compensation. The table displays the results of event time regressions according to equation (3.16) for S&P1500 CEOs over the period 1993-2001. π_-^F, π_-^V, π_+^F, π_+^V are dummy variables indicating the pre- and post-turnover periods and whether CEO turnover was forced or voluntary. Subscript "-" indicates the pre-turnover period while subscript "+" indicates the post-turnover period. Superscript "F" indicates that turnover in period zero was forced, superscript "V" indicates the complementary case of voluntary turnover. P-values of differences in coefficients are calculated from Wald statistics using standard errors clustered at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent Variable	Ln(Total comp)		% Equity-based pay	
	(1)	(2)	(3)	(4)
$\pi_-^F - \pi_-^V$	0.0193	-0.0731	0.0428***	0.0058
	(0.634)	(0.187)	(0.002)	(0.776)
$\pi_+^F - \pi_+^V$	0.1499***	0.1119***	0.0019	-0.0091
	(0.000)	(0.008)	(0.897)	(0.578)
$(\pi_+^F - \pi_+^V) - (\pi_-^F - \pi_-^V)$	0.1305***	0.1850***	-0.0409**	-0.0149
	(0.008)	(0.003)	(0.026)	(0.528)
Firm-specific controls	Yes	Yes	Yes	Yes
Corporate governance controls	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	8816	5264	8954	5343
Adjusted R-squared	0.54	0.54	0.21	0.20

We now turn to the question of whether the pattern of CEO compensation revealed in Figure 3.7 could be the result of differential trends towards incentive provision across firms. If this were the case we would expect incentive compensation, total compensation and turnover to be correlated. In our empirical setup this would suggest that the trend toward higher total compensation in firms where forced turnover occurs should be accompanied by a trend towards more incentive compensation.

To test this hypothesis we re-run the regressions according to equation (3.16) both with period-specific and pre- and post-turnover indicators, but replace the dependent variable with the fraction of equity-based pay in total compensation. Figure 3.8 shows the point estimates of the coefficient differences $\pi_\tau^F - \pi_\tau^V$ by period and the respective confidence intervals. Contrary to the incentive hypothesis, the proportion of equity-based pay does not systematically increase after forced turnover. This is confirmed by the regression results which use the coarse definition for the indicator variables shown in columns (3) and (4) of Table 3.10. If anything, we observe a decrease rather than an increase of equity-based incentives in firms where forced turnover occurs. This would be consistent with incentive substitution rather than a trend towards stronger performance sensitivity of both pay and turnover. Holding turnover risk constant, we would expect total compensation to decrease as CEOs are exposed to lower stock price risk. Therefore, a rise in CEO pay can only be explained by other factors, such as a turnover risk premium.

Taken together these results strongly support the notion that turnover risk has a causal effect on CEO compensation. The occurrence of forced turnover raises total compensation by about 11 to 15 percentage points, an effect that cannot be explained by a trend towards higher performance sensitivity of both CEO compensation and turnover. One limitation of the regression approach used in this section is that it does not allow us to quantify exactly how turnover risk is compensated with higher pay levels. If forced turnover occurs, the perception of turnover risk arguably rises, but we have no means of estimating exactly by how much.

3.5 Conclusion

This paper quantifies the price of exogenous turnover risk in executive compensation. Our empirical analysis suggests that for the median CEO from the S&P 1500 sample, a one percentage point increase in turnover risk is associated with an increase in total compensation of more than $200,000, a large amount. In interpreting this number, we are able to rule out reverse causation: Compensation levels before forced turnover are not different from compensation levels before voluntary turnover. We are also able to rule out the idea that the turnover risk premium is simply a consequence of stronger incentives overall: Equity-based compensation after forced turnover is used to the same extent as after voluntary turnover.

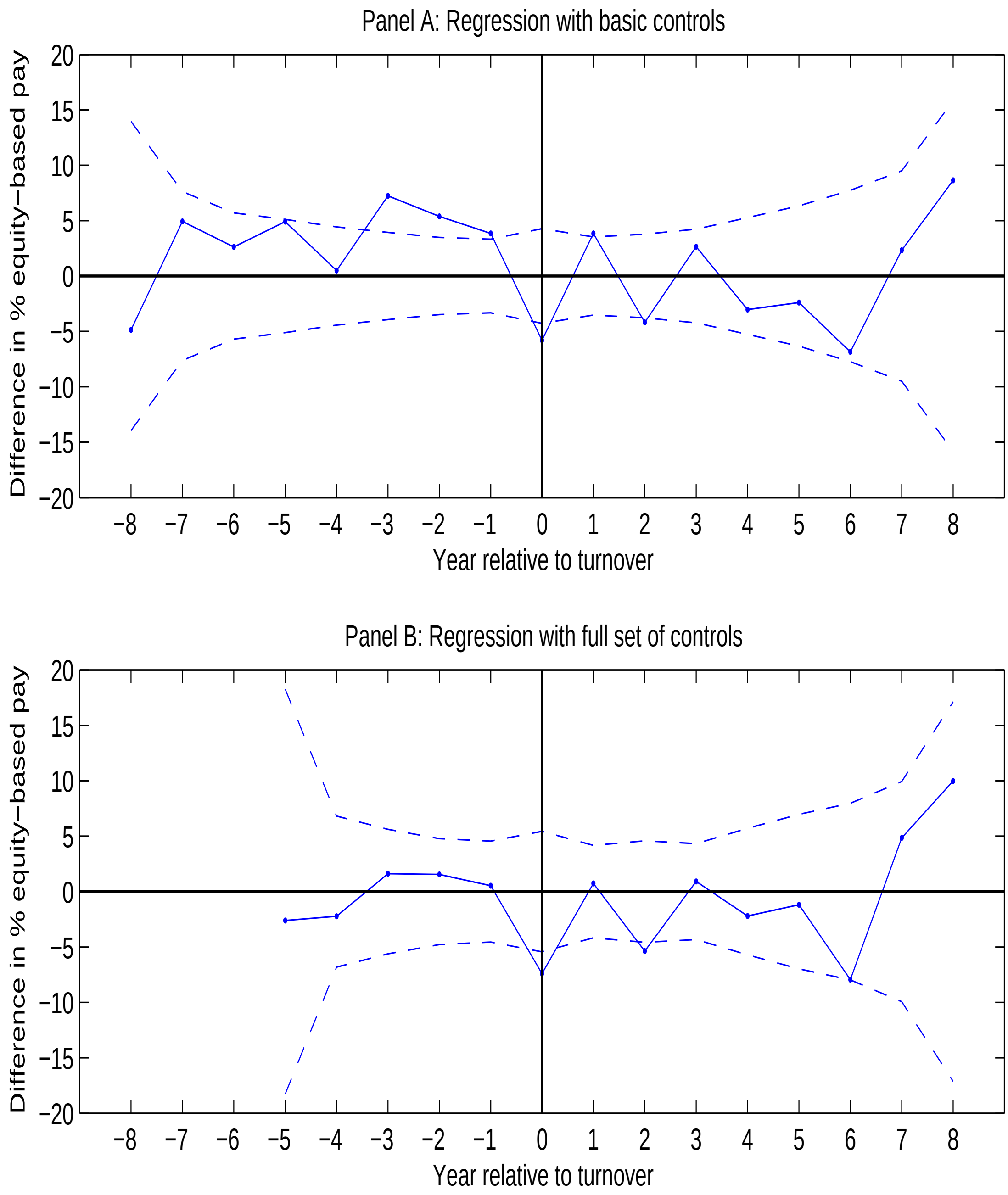

Figure 3.8: Difference in percentage of equity-based compensation. The figure shows the difference in the percentage of equity-based CEO compensation between CEOs in firms where turnover is forced and firms where turnover is voluntary. The solid line plots the point estimates of the coefficent differences $\pi_\tau^F - \pi_\tau^V$ by period. The dashed lines represent 90% confidence intervals of a two-sided Wald test that the coeffiient differences are equal to zero. Year zero refers to the last fiscal year the incumbent CEO is in office.

The turnover risk premium is likely due to a number of factors. First, unvested equity-based compensation may be subject to forfeiture in case of forced turnover. Second, concerns about reduced earnings opportunities following dismission are likely to be substantial. Other factors may also play a role, however. These include, for example, personal, psychological costs. Yet another possible explanation draws on evidence from behavioral economics. Even though the historical average probability of forced turnover is small (2.53% over 1993-2001), CEOs may overestimate these probabilities as they represent an extreme event. Thus, probability weighting as proposed in cumulative prospect theory Kahneman and Tversky (1992) may lead executives to perceive turnover risk as much higher than it actually is, hence overstating the expected losses. Indeed, the difference between the empirical turnover risk premium and the discount to executive compensation when accounting for the mere monetary consequences of forced turnover gives an approximation of these costs. Further disentangling the various sources of the empirical premium for exogenous turnover risk is an interesting avenue for future research.

Appendix 3.A Valuing vulnerable executive compensation

In this section we develop a model of the certainty equivalent compensation accounting for the risk of forfeiture in case of turnover. We focus on forced turnover as the CEO's compensation packages typically do not lose value in other cases of turnover. In the cases of change-in-control and regular retirement CEOs typically retain their unvested compensation packages, while in the case of a job change the new employer usually compensates the CEO for forfeited pay packages of his former employer.

In modeling the valuation effects of forced turnover, we follow the standard provisions stipulated in public U.S. corporations' incentive compensation plans which require the cancelation of unvested stocks and options in case of executive turnover. For vested options, we assume, again consistent with standard provisions, immediate exercise at the time of turnover.

We define three dates which are known at the time the option or stock grant is made: the vesting date, T_V, the maturity date of the option grant, T, and the regular retirement date of the CEO, T_R, which we set to 65. Forced turnover can occur between the grant date and the date of retirement. It will, however, only have a value-decreasing effect on the executive's option grant if it also occurs before expiry of the option. Thus forced turnover is value-decreasing on the interval $[0, T \wedge T_R)$ only, where $\wedge$ denotes "the smaller of." One can think of the case when the CEO's regular retirement date is before the option's maturity date, $T_R < T$, as the case of an "senior CEO" and the case when $T_R \geq T$ as that of a "junior CEO."

We define the random time T_F as the time the CEO is forced out of office. We assume a constant hazard rate of forced turnover with density function f_{T_F}:[12]

$$f_{T_F}(t) = \lambda e^{-\lambda t} \qquad t \in [0, \infty), \tag{3.17}$$

where λ is the hazard rate. We consider the payoffs from option and stock grants separately. First, consider the option grant.[13] We use the following notation: $\mathbf{1}_{T_F < T_V \wedge T_R}$ is an indicator variable that is equal to 1 if the condition in the subscript holds. For example, in this case the variable is 1 if the CEO is forced out at a date before his options are vested and before he retires. The CEO's wealth at time T from the option grant is then given by

$$\begin{aligned} W_T^O &= \mathbf{1}_{T_F < T_V \wedge T_R} \cdot 0 + \mathbf{1}_{T_F \geq T_V \wedge T_R} \mathbf{1}_{T_F < T_R \wedge T} \cdot n[P_{T_F} - X]^+ e^{r(T - T_F)} + \mathbf{1}_{T_F \geq T_R \wedge T} \cdot n[P_T - X]^+ \\ &= \mathbf{1}_{T_F \geq T_V \wedge T_R} \mathbf{1}_{T_F < T_R \wedge T} \cdot n[P_{T_F} - X]^+ e^{r(T - T_F)} + \mathbf{1}_{T_F \geq T_R \wedge T} \cdot n[P_T - X]^+ \end{aligned} \tag{3.18}$$

where P_{T_F} and P_T are the stock prices at T_F and T, respectively, n is the number of options in the grant, X is the strike price, and r is the risk-free rate. The first term indicates the event that the CEO is fired before the options vest and before he retires in which case the payoff is zero. The second term indicates the event that the CEO is fired between the vesting date and the smaller of his retirement and the option's expiry date. This is the case of accelerated exercise in which the payoff of a single option is $[P_{T_F} - X]^+$,

[12]One can, in principle, accommodate the feature that the probability of forced turnover, conditional on survival, depends on factors such as time, industry performance, and firm performance by specifying the hazard rate as a function of a set of these variables. In the empirical section, we use time- and industry-specific hazard rates.

[13]We consider European options in our main analysis. This assumption is restrictive and does not, in particular, allow for the empirically documented early exercise of executive stock options (except for involuntary exercise of vested options in the event of turnover). By doing so, we retain tractability and intuition of the model relative to American option valuation which necessarily relies on simulation (see Carpenter (1998), Carpenter (2000) and Ingersoll (2006) for an analysis of subjective values of American style options). In any case, the differential effect of turnover/cancelation on European and American option values is likely to be negligible as cancelation occurs in the vesting period when the option cannot be exercised anyway.

the intrinsic value at departure. We assume that the CEO receives this payoff in cash and invests it in the risk-free asset until T. The third term represents the case when the CEO remains in office until regular retirement or option maturity. In this case he gets the intrinsic value of the option at time T.

Analogously, the CEO's payoff from his restricted stock grant is given by

$$\begin{aligned} W_T^S &= \mathbf{1}_{T_F < T_V \wedge T_R} \cdot 0 + \mathbf{1}_{T_F \geq T_V \wedge T_R} \mathbf{1}_{T_F < T_R \wedge T} \cdot sP_{T_F} e^{r(T-T_F)} + \mathbf{1}_{T_F \geq T_R \wedge T} \cdot sP_T \\ &= \mathbf{1}_{T_F \geq T_V \wedge T_R} \mathbf{1}_{T_F < T_R \wedge T} \cdot sP_{T_F} e^{r(T-T_F)} + \mathbf{1}_{T_F \geq T_R \wedge T} \cdot sP_T \end{aligned} \tag{3.19}$$

where the first term refers to the event that the CEO is dismissed before vesting and retirement, in which case the payoff is zero, and the second term indicates the complementary event, in which case the CEO gets the full value of his stock grant at T_F. As with the option payoff at T_F, we again assume that the stock is sold and the proceeds are invested in the risk-free asset.

Assuming that the CEO has outside wealth W_0 invested at the risk-free rate, r, his total wealth at time T is

$$W_T = W_0 e^{rT} + W_T^O + W_T^S \tag{3.20}$$

If instead of the risky, equity-based compensation the CEO were awarded the amount C in riskless cash, his wealth at time T is given by

$$W_T^C = (W_0 + C) e^{rT} \tag{3.21}$$

The certainty equivalent value of the CEO's entire package of equity-based compensation is defined as the amount C^* that equates expected utilities of equations (3.20) and (3.21).

As opposed to the basic model without turnover which contains only one source of uncertainty, the stock price at the maturity date, P_T, we now have to account for a second source of uncertainty, the time of forced turnover, T_F. Because of the possibility of accelerated exercise, expected utility then becomes a function of three random variables,

T_F, P_{T_F}, and P_T. We have

$$\begin{aligned}
&E[U(W_T(T_F, P_{T_F}, P_T))] \\
&\quad = E\big[E[U(W_T(P_{T_F}, P_T))|T_F]\big] \\
&\quad = E\big[\int_0^\infty \int_0^\infty U(W_T(P_{T_F}, P_T)) f_{P_T|P_{T_F}}(P_T) f_{P_{T_F}|T_F}(P_{T_F}) dP_T dP_{T_F}\big] \\
&\quad = \int_0^\infty \int_0^\infty \int_0^\infty U(W_T(P_{T_F}, P_T)) f_{P_T|P_{T_F}}(P_T) f_{P_{T_F}|T_F}(P_{T_F}) f_{T_F}(T_F) dP_T dP_{T_F} dT_F
\end{aligned}$$

where the first three steps on the right hand side are obtained applying the law of iterated expectation. Further evaluating this expression yields

$$\begin{aligned}
&E[U(W_T(T_F, P_{T_F}, P_T))] \\
&\quad = P[T_F < T_V \wedge T_R] \cdot U(W_0 e^{rT}) \\
&\quad + \int_{T_V \wedge T_R}^{T \wedge T_R} \int_0^\infty U(W_T(P_{T_F})) f_{P_{T_F}|T_F}(P_{T_F}) f_{T_F}(T_F) dP_{T_F} dT_F \\
&\quad + P[T_F > T \wedge T_R] \cdot \int_0^\infty U(n[P_T - X]^+ + sP_T + W_0 e^{rT}) f_{P_T}(P_T) dP_T \\
&\quad = (1 - e^{-\lambda(T_V \wedge T_R)}) \cdot U(W_0 e^{rT}) \\
&\quad + \int_{T_V \wedge T_R}^{T \wedge T_R} \int_0^\infty U(W_T(P_{T_F})) f_{P_{T_F}|T_F}(P_{T_F}) f_{T_F}(T_F) dP_{T_F} dT_F \\
&\quad + e^{-\lambda(T \wedge T_R)} \cdot \int_0^\infty U(n[P_T - X]^+ + sP_T + W_0 e^{rT}) f_{P_T}(P_T) dP_T
\end{aligned}$$

where steps four and five are simplifications obtained by splitting the integral over T_F in three parts. For the first part, $0 < T_F < T_V \wedge T_R$, expected utility is independent of the stock price. For the second part, $T_V \wedge T_R \leq T_F < T \wedge T_R$, expected utility depends on the stock price at departure, P_{T_F}, but not on P_T. For the third interval, $T_F \geq T \wedge T_R$, expected utility depends on the stock price at T, P_T, but not on P_{T_F}.

We further assume that the CEO has a constant relative risk aversion (CRRA) utility function of the form $U(W_T) = 1/(1-\rho)W_T^{1-\rho}$, where ρ is the coefficient of risk aversion. The certainty equivalent, C^*, then has to be computed numerically.

Appendix 3.B Valuing risk-adjusted compensation packages

Our calculations of certainty equivalent values of full CEO compensation packages without forfeiture risk follow the methodology of Hall and Murphy (2002). For details see the original paper. We outline here the extended methodology applying to the valuation which accounts for forfeiture risk. Calculations are based on the following data:

s_0	number of shares owned excluding the current year grant
s_1	number of restricted shares granted in the current year
n_0	number of stock options owned excluding the current year grant
n_1	number of stock options granted in the current year
X_0	average exercise price of previously granted options
X_1	vector of exercise prices of current year options
Salary	base salary plus all non-deferred compensation except bonus
Bonus	bonus plus payouts from long-term incentive plans
T	option term or term of the largest grant (in case of multiple grants)
T_V	vesting period (assumed to be 2.5 years)
T_R	years to regular retirement = max(0, 65 - age)
σ	annualized volatility of monthly continuous returns, calculated over 48 months
β	equity beta, calculated from monthly stock returns relative to the value-weighted CRSP index over 48 months
r_f	yield of 1-year U.S. Treasury Bills
$(r_m - r_f)$	equity premium (assumed to be 6.5%)
ρ	coefficient of relative risk aversion (assumed to be 2 or 3)
W_0	non-firm-related safe wealth (assumed to be the greater of $5 million and four times risk-neutral total compensation)
f^O	number of previously granted, exercisable options divided by the total number of previously granted options
f^S	number of previously granted, vested stocks divided by the total number of previously granted stocks

Following Hall and Murphy (2002), we discount bonuses by 20% to account for the fact that bonuses are often paid out partially in company stock rather than in cash and thus are risky.

In order to account for previously granted stocks and options, we need to extend equations (3.20) and (3.21) for prior equity-based pay in the CEO's portfolio. We call the terminal wealth due to previously granted options $\overline{W}_T^O$, and terminal wealth due to previously granted stock $\overline{W}_T^S$. We also have to make assumptions regarding the remaining vesting period of previous equity-based pay. This data is not available in ExecuComp. ExecuComp does provide, however, the number of unvested stocks and options. We assume that unvested stocks and options vest gradually over $[0, T_V - 1]$, i.e. we assume that the latest vesting date of previous equity-based pay is one year before the vesting date of current compensation. Accounting for the fact that unvested previous compensation can be forfeited we have

$$\begin{aligned}\overline{W}_T^O = & \mathbf{1}_{T_F < T_V - 1} \cdot (f^O + (1 - f^O)\frac{T_F}{T_V - 1}) \cdot n_0[P_{T_F} - X_0]^+ e^{r(T - T_F)} \\ & + \mathbf{1}_{T_F \geq T_V - 1}\mathbf{1}_{T_F < T} \cdot n_0[P_{T_F} - X_0]^+ e^{r(T - T_F)} + \mathbf{1}_{T_F \geq T}[P_T - X_0]^+ \end{aligned} \tag{3.22}$$

and

$$\begin{aligned}\overline{W}_T^S = & \mathbf{1}_{T_F < T_V - 1} \cdot (f^S + (1 - f^S)\frac{T_F}{T_V - 1}) \cdot s_0 P_{T_F} e^{r(T - T_F)} \\ & + \mathbf{1}_{T_F \geq T_V - 1}\mathbf{1}_{T_F < T} \cdot s_0 P_{T_F} e^{r(T - T_F)} + \mathbf{1}_{T_F \geq T} P_T \end{aligned} \tag{3.23}$$

where f^S and f^O are the fractions of vested previous stocks and options. The equivalent of equation (3.4) with risky current compensation then becomes

$$W_T = (W_0 + Salary + 0.8Bonus)e^{rT} + W_T^O + \overline{W}_T^O + W_T^S + \overline{W}_T^S \tag{3.24}$$

and the equivalent of equation (3.5), where risky current compensation is replaced by the safe cash amount C, is given by

$$W_T^C = (W_0 + C)e^{rT} + \overline{W}_T^O + \overline{W}_T^S \tag{3.25}$$

The certainty equivalent C^* is that amount of C which equates expected utilities of equations (3.24) and (3.25):

$$E[U(W_T(T_F, P_{T_F}, P_T))] \equiv E[U(W_T^C(T_F, P_{T_F}, P_T))] \tag{3.26}$$

Appendix 3.C Tables

Table 3.12: Event time regressions of log total compensation. The table displays the results of event time regressions according to equation (3.16) for S&P1500 CEOs over the period 1993-2001. π_τ^F and π_τ^V are dummy variables indicating the period relative to the year of turnover and whether CEO turnover was forced or voluntary. The subscript indicates the period relative to the turnover year. The superscript "F" indicates that turnover in period zero was forced, superscript "V" indicates the complementary case of voluntary turnover. P-values of differences in coefficients are calculated from Wald statistics using standard errors clustered at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. The point estimates of the coefficient differences are plotted in Figure 3.7.

	(1)		(2)	
Dependent Variable	Ln(Total Comp)		Ln(Total Comp)	
	$\Delta\pi_\tau$	P-value	$\Delta\pi_\tau$	P-value
$\pi_{-8}^F - \pi_{-8}^V$	-0.0851	(0.758)		
$\pi_{-7}^F - \pi_{-7}^V$	-0.1258	(0.301)		
$\pi_{-6}^F - \pi_{-6}^V$	0.1542	(0.107)		
$\pi_{-5}^F - \pi_{-5}^V$	0.1509**	(0.047)	0.0176	(0.935)
$\pi_{-4}^F - \pi_{-4}^V$	-0.0294	(0.671)	-0.1617	(0.189)
$\pi_{-3}^F - \pi_{-3}^V$	0.0535	(0.382)	-0.0390	(0.667)
$\pi_{-2}^F - \pi_{-2}^V$	0.0227	(0.666)	-0.0166	(0.823)
$\pi_{-1}^F - \pi_{-1}^V$	-0.0381	(0.479)	-0.0963	(0.194)
$\pi_{0}^F - \pi_{0}^V$	-0.0356	(0.616)	-0.0887	(0.311)
$\pi_{1}^F - \pi_{1}^V$	0.1556***	(0.007)	0.0549	(0.440)
$\pi_{2}^F - \pi_{2}^V$	0.0697	(0.219)	0.0278	(0.691)
$\pi_{3}^F - \pi_{3}^V$	0.2336***	(0.001)	0.2023***	(0.005)
$\pi_{4}^F - \pi_{4}^V$	0.1862**	(0.020)	0.2054**	(0.014)
$\pi_{5}^F - \pi_{5}^V$	0.1020	(0.253)	0.1180	(0.222)
$\pi_{6}^F - \pi_{6}^V$	0.0803	(0.435)	0.0097	(0.921)
$\pi_{7}^F - \pi_{7}^V$	0.2516*	(0.097)	0.2786*	(0.083)
$\pi_{8}^F - \pi_{8}^V$	0.2376	(0.228)	0.2005	(0.349)
Firm-specific controls	Yes		Yes	
Corporate governance controls	No		Yes	
Year fixed effects	Yes		Yes	
Industry fixed effects	Yes		Yes	
Observations	8828		5273	
Adjusted R-squared	0.99		0.99	

Bibliography

Aghion, P. and P. Bolton (1992): "An Incomplete Contracts Approach to Financial Contracting," *Review of Financial Studies*, 59, 473–494.

Anderson, R. W. and S. Sundaresan (1996): "Design and Valuation of Debt Contracts," *The Review of Financial Studies*, 9, 37–68.

Anderson, T. W. and C. Hsiao (1982): "Formulation and Estimation of Dynamic Models using Panel Data," *Journal of Econometrics*, 18, 47–82.

Arellano, M. and S. R. Bond (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, 58, 277–297.

Asquith, P., R. Gertner, and D. Scharfstein (1994): "Anatomy of Financial Distress: An Examination of Junk Bond Issuers," *Quarterly Journal of Economics*, 109, 625–685.

Avramov, D., G. Jostova, and A. Philipov (2004): "Corporate Credit Risk Changes: Common Factors and Firm-Level Fundamentals," *Working Paper*.

Barclay, M. J. and C. W. Smith (1995a): "The Priority Structure of Corporate Liabilities," *The Journal of Finance*, 50, 899–917.

Barclay, M. J. and C. W. J. Smith (1995b): "The Maturity Structure of Corporate Debt," *The Journal of Finance*, 50, 609–631.

Bartram, S. M., G. W. Brown, and F. R. Fehle (2004): "International Evidence on Financial Derivatives Use," *Working Paper, University of North Carolina*.

Bebchuk, L. and J. Fried (2004): *Pay without performance*, Cambridge: Harvard University Press.

Benmelech, E., M. J. Garmaise, and T. J. Moskowitz (2004): "Do Liquidation Values affect Financial Contracts? Evidence from Commercial Loan Contracts and Zoning Regulation," *Working Paper, Graduate School of Business, University of Chicago*.

Berglöf, E. and E.-L. von Thadden (1994): "Short-Term versus Long-Term Interests: Capital Structure with Multiple Investors," *The Quarterly Journal of Economics*, 109, 1055–1084.

Bergman, Y. Z. and J. L. Callen (1991): "Opportunistic Underinvestment in Debt Renegotiation and Capital Structure," *Journal of Financial Economics*, 29, 137–171.

Berlin, M. and J. Loeys (1988): "Bond Covenants and Delegated Monitoring," *The Journal of Finance*, 43, 397–412.

Best, R. and H. Zhang (1993): "Alternative Information Sources and the Information Content of Bank Loans," *The Journal of Finance*, 48, 1507–1522.

Betker, B. L. (1995): "Management's Incentives, Equity's Bargaining Power, and Deviations from Absolute Priority in Chapter 11 Bankruptcies," *Journal of Business*, 68, 161–183.

Bhagat, S. and P. Frost (1986): "Issuing Costs to Existing Shareholders in Competitive and Negotiated Underwritten Public Utility Equity Offerings," *Journal of Financial Economics*, 15, 233–259.

Black, F. and M. Scholes (1973): "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy*, 81, 637–654.

Blackwell, D. and D. Kidwell (1988): "An Investigation of Cost Differences Between Public Sales and Private Placements of Debt," *Journal of Financial Economics*, 22, 253–278.

Bolton, P. and D. S. Scharfstein (1996): "Optimal Debt Structure and the Number of Creditors," *Journal of Political Economy*, 104, 1–25.

Booz-Allen-Hamilton (2005): "CEO Succession 2005: The Crest of the Wave," .

Bris, A. and I. Welch (2005): "The Optimal Concentration of Creditors," *The Journal of Finance*, 60, 2193–2212.

Brown, K. C., W. van Harlow, and L. Starkes (1996): "Of Tournaments and Temptations: An Analysis of Managerial Incentives in the Mutual Funds Industry," *The Journal of Finance*, 51, 85–110.

Brown, S., W. Goetzmann, and J. Park (2001): "Careers and Survival: Competition and Risk in the Hedge Fund and CTA Industry," *The Journal of Finance*, 56, 1869–1886.

Brunner, A. and J. P. Krahnen (2002): "Multiple Lenders and Corporate Distress: Evidence on Debt Restructuring," *Working Paper:*.

Campbell, J., M. Lettau, B. G. Malkiel, and Y. Xu (2001): "Have individual stocks become more volatile? An empirical explanation of idiosyncraatic risk," *The Journal of Finance*, 56, 1–43.

Campbell, J. and G. Taksler (2003): "Equity Volatility and Corporate Bond Yields," *The Journal of Finance*, 58, 2321–2349.

Carpenter, J. N. (1998): "The exercise and valuation of executive stock options," *Journal of Financial Economics*, 127–158.

——— (2000): "Does option compensation increase managerial risk appetite," *The Journal of Finance*, 55, 2311–2331.

Chakraborty, A., S. Sheikh, and N. Subramanian (2004): "Termination risk and managerial risk-taking," Working Paper, Brandeis University.

Chemmanur, T. J. and P. Fulghieri (1994): "Reputation, Renegotiation, and the Choice between Bank Loans and Publicly Traded Debt," *Review of Financial Studies*, 7, 475–506.

Chevalier, J. and G. Ellison (1997): "Risk Taking by Mutual Funds as a Response to Incentives," *Journal of Political Economy*, 114, 389–432.

Core, J. and W. Guay (2002): "Estimating the Value of Employee Stock Option Portfolios and their Sensitivities to Price and Volatility," *Journal of Accounting Research*, 40, 613–630.

Crosbie, P. J. and J. Bohn (2003): "Modeling Default Risk," Available at http://www.moodyskmv.com.

Dahiya, S. and D. Yermack (2007): "You can't take it with you: Sunset provisions for equity compensation when managers retire, resign or die," Working Paper, NYU.

Davydenko, S. and I. A. Strebulaev (2007): "Strategic Behavior and Credit Spreads: An Empirical Investigation," *The Journal of Finance*, forthcoming.

Davydenko, S. A. and J. R. Franks (2004): "Do Bankruptcy Codes Matter? A Study of Defaults in France, Germany, and the UK," *Working Paper*.

Detragiache, E. (1994): "Public versus Private Borrowing: A Theory with Implications for Bankruptcy Reform," *Journal of Financial Intermediation*, 3, 327–354.

Detragiache, E., P. Garella, and L. Guiso (2000): "Multiple versus Single Banking Relationships: Theory and Evidence," *The Journal of Finance*, 55, 1133–1161.

Dezsö, C. (2006): "Entrenchment and Changes in Performance Following CEO Turnover," Working Paper, NYU.

Diamond, D. W. (1984): "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies*, 51, 393–414.

——— (1989): "Reputation Acquisition in Debt Markets," *Journal of Political Economy*, 97, 828–862.

——— (1991): "Monitoring and Reputation: The Choice between Bank Loans and Directly Placed Debt," *Journal of Political Economy*, 99, 689–721.

——— (2004): "Committing to Commit: Short-term Debt when Enforcement is Costly," *The Journal of Finance*, 59, 1447–1479.

Dlugosz, J., R. Fahlenbrach, P. Gompers, and A. Metrick (2005): "Large Blocks of Stock: Prevalence, Size, and Measurement," *Working Paper*.

Duan, J.-C., G. Gauthier, and J.-G. Simonato (2004): "On the Equivalence of the KMV and Maximum Likelihood Methods for Structural Credit Risk Models," *Working Paper, University of Toronto and HEC Montreal*.

Duffee, G. (1998): "The Relation Between Treasury Yields and Corporate Bond Yield Spreads," *The Journal of Finance*, 53, 2225–2241.

Esty, B. C. and W. L. Megginson (2004): "Creditor Rights, Enforcement, and Debt Ownership Structure: Evidence from the Global Syndicated Loans Market," *Working Paper*.

Fama, E. (1985): "What's Different about Banks?" *Journal of Monetary Economics*, 15, 29–39.

Fama, E. F. and K. R. French (1997): "Industry Costs of Equity," *Journal of Financial Economics*, 43, 153–193.

Fan, H. and S. Sundaresan (2000): "Debt Valuation, Renegotiation, and Optimal Dividend Policy," *The Review of Financial Studies*, 13, 1057–1099.

Fang, M. and R. Zhong (2004): "Default Risk, Firm's Characteristics, and Risk Shifting," *Yale ICF Working Paper No. 04-21*.

Fee, E. C. and C. J. Hadlock (2004): "Management Turnover across the Corporate Hierarchy," *Journal of Accounting and Economics*, 37, 3–38.

Franks, J. R., K. G. Nyborg, and W. N. Torous (1996): "A Comparison of US, UK and German Insolvency Codes," *Financial Management*.

Franks, J. R. and W. N. Torous (1989): "An Empirical Investigation of U.S. Firms in Renegotiation," *The Journal of Finance*, 44, 747–769.

——— (1994): "A Comparison of Financial Recontracting in Distressed Exchanges and Chapter 11 Reorganization," *Journal of Financial Economics*, 35, 349–370.

Gabaix, X. and A. Landier (2006): "Why has CEO pay increased so much?" Working Paper, MIT.

Geske, R. (1979): "The Valuation of Compound Options," *Journal of Financial Economics*, 7, 63–81.

Gilson, S., K. John, and L. Lang (1990): "Troubled Debt Restructurings: An Empirical Study of Private Reorganization of Firms in Default," *Journal of Financial Economics*, 27, 315–53.

Gompers, P. A., J. L. Ishii, and A. Metrick (2003): "Corporate Governance and Equity Prices," *Quarterly Journal of Economics*.

Goyal, A. and P. Santa-Clara (2003): "Idiosycratic Risk Matters!" *The Journal of Finance*, 58, 975–1007.

Graham, J. R. (1996): "Debt and the Marginal Tax Rate," *Journal of Financial Economics*, 41, 41–73.

Graham, J. R. and C. R. Harvey (2001): "The Theory and Practice of Corporate Finance: Evidence from the Field," *Journal of Financial Economics*, 60, 187–243.

Guay, W. and S. Kothari (2003): "How Much Do Firms Hedge with Derivatives?" *Journal of Financial Economics*, 70, 423–461.

Hall, B. J. and K. J. Murphy (2002): "Stock Options for Undiversified Executives," *Journal of Accounting and Economics*, 33, 3–42.

——— (2003): "The Trouble with Stock Options," *Journal of Economic Perspectives*, 17, 49–70.

Hallman, G., J. C. Hartzell, and C. Parsons (2005): "Carrots and sticks: The threat of dismissal and incentive compensation," Working Paper, University of Texas at Austin.

Hart, O. and J. Moore (1994): "A Theory of Debt Based on the Inalienability of Human Capital," *Quarterly Journal of Econonmics*, 109, 841–879.

——— (1998): "Default and Renegotiation: A Dynamic Model of Debt," *Quarterly Journal of Economics*, 113, 1–43.

Hege, U. and P. Mella-Barral (2005): "Repeated Dilution of Diffusely Held Debt," *Journal of Business*.

HELWEGE, J. (1999): "How Long do Junk Bonds Spend in Default?" *The Journal of Finance*, 54, 341–347.

HERMALIN, B. E. (2005): "Trends in Corporate Governance," *The Journal of Finance*, 60, 2351–2384.

HOUSTON, J. AND C. JAMES (1996): "Bank Information Monopolies and the Mix of Private and Public Debt," *The Journal of Finance*, 51, 1863–1889.

HUANG, J.-Z. AND M. HUANG (2003): "Hoe Much of the Corporate-Treasury Yield Spread is Due to Credit Risk?" *Working Paper.*

HUSON, M. R., R. PARRINO, AND L. T. STARKS (2001): "Internal Monitoring Mechanisms and CEO Turnover: A Long-Term Perspective," *The Journal of Finance*, 56, 2265–2297.

INGERSOLL, J. E. (2006): "The Subjective and Objective Evaluation of Incentive Stock Options," *Journal of Business*, 79.

JENSEN, M. C. AND W. H. MECKLING (1976): "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," *Journal of Financial Economics*, 3, 305–360.

JENSEN, M. C. AND K. J. MURPHY (1990): "Performance Pay and Top Management Incentives," *Journal of Political Economy*, 98, 225–264.

JENTER, D. AND F. KANAAN (2006): "CEO turnover and relative performance evaluation," *Working Paper, MIT.*

JOHNSON, S. (1997): "An Empirical Analysis of the Determinants of Corporate Debt Ownership Structure," *Journal of Financial and Quantitative Analysis*, 32, 47–69.

JU, N. AND H. OU-YANG (2005): "Asset Substitution and Underinvestment," *Working Paper.*

KAHNEMAN, D. AND A. TVERSKY (1992): "Advances in Prospect Theory: Cumulative Representation of Uncertainty," *Journal of Risk and Uncertainty*, 5, 297–323.

KAPLAN, S. N. AND B. A. MINTON (2006): "How has CEO turnover changed? Increasingly perfromance sensitive boards and increasingly uneasy CEOs," Working Paper, University of Chicago.

KRISHNASWAMI, S. AND V. SUBRAMANIAM (1999): "Information Asymmetry, Valuation, and the Corporate Spin-off Decision," *Journal of Financial Economics*, 53, 73–112.

LAMBERT, R. A., D. F. LARCKER, AND R. E. VERRECCHIA (1991): "Portfolio Considerations in Valuing Executive Compensation," *Journal of Accounting Research*, 29, 129–149.

LaPorta, R., F. Lopez-de Silanes, A. Shleifer, and R. W. Vishny (1998): "Law and Finance," *Journal of Political Economy*, 106, 1113–1155.

Larsen (2006): "Default Risk, Debt Maturity and Levered Equity's Risk Shifting Incentives," *Working Paper, Aarhus University.*

Leland, H. E. and D. H. Pyle (1977): "Informational asymmetries, financial structure, and financial intermediation," *The Journal of Finance*, 32, 371–387.

Leland, H. E. and K. B. Toft (1998): "Optimal Capital Structure, Endogenous Bankruptcy, and the Term Structure of Credit Spreads," *The Journal of Finance*, 51, 987–1019.

Mella-Barral, P. and W. Perraudin (1997): "Strategic Debt Service," *The Journal of Finance*, 52, 531–556.

Modigliani, F. and M. Miller (1958): "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review*, 48, 267–297.

——— (1963): "Corporate Income Taxes and the Cost of Capital: A Correction," *American Economic Review*, 53, 433–443.

Murphy, K. J. and J. Zaboinik (2004): "CEO pay and appointments: A market-based explanation for recent trends," *American Economic Review*, 94, 192–196.

Myers, S. C. (1977): "Determinants of Corporate Borrowing," *Journal of Financial Economics*, 5, 147–175.

——— (1984): "The Capital Structure Puzzle," *The Journal of Finance*, 39, 575–592.

Ongena, S. and D. C. Smith (2000): "What Determines the Number of Bank Relationships? Cross-Country Evidence," *Journal of Financial Intermediation*, 9, 26–56.

Parrino, R. (1997): "CEO turnover and outside succession: A cross-sectional analysis," *Journal of Financial Economics*, 46, 165–197.

Rusticus, T. (2006): "Executive Severance Agreements," Working Paper, University of Pennsylvania.

Sletten, E. and T. Lys (2006): "Motives for and Risk-Incentive Implications of CEO Severance," Working Paper, Northwestern University.

Smith, C. (1986): "Investment Banking and the Capital Acquisition Process," *Journal of Financial Economics*, 15, 3–29.

Stohs, M. H. and D. C. Mauer (1996): "The Determinants of Corporate Debt Maturity Structure," *Journal of Business*, 69, 279–312.

Stulz, R. and H. Johnson (1985): "An Analysis od Secured Debt," *Journal of Financial Economics*, 14, 501–521.

Subramanian, N., A. Chakraborty, and S. Sheikh (2002): "Performance incentives, performance pressure, and executive turnover," Working Paper, Brandeis University.

Thomas, S. (2002): "Firm Diversification and Asymmetric Information: Evidence form Analysts' Forecasts and Earnings Announcements," *Journal of Financial Economics*.

Vassalou, M. and Y. Xing (2004): "Default Risk in Equity Returns," *The Journal of Finance*, 59, 831–868.

Curriculum Vitae

FLORIAN S. PETERS

Office Contact Information
Swiss Banking Institute
Plattenstrasse 22
8032 Zürich
Switzerland
+41 (0)44 6344047
fpeters@isb.uzh.ch

Home Contact Information
Üetlibergstrasse 31
8045 Zürich
Switzerland
+41 (0)43 3332474
+41 (0)79 6005380
florian.s.peters@gmail.com

EDUCATION

Doctoral studies, University of Zurich, Switzerland (Swiss Finance Institute), October 2003 - May 2008. Dissertation: Essays in Corporate Finance. Primary Advisor: Professor Michel A. Habib.

M.A., Economics, University of Cologne, Germany, May 2002.

B.A., Economics, University of Heidelberg, Germany, April 1999.

Preliminary examination, Medicine, Free University of Berlin, Germany, September 1996.

TEACHING EXPERIENCE

Introduction to Economics and Business Administration, undergraduate course, University of Zurich, fall 2005.

Corporate Finance I, undergraduate course, University of Zurich, spring 2006.

RESEARCH PAPERS

"The Executive Turnover Risk Premium" (with Alexander Wagner), 2007.

"Vulnerable Executive Compensation" (with Alexander Wagner), 2007.

"Asset Substitution: An Empirical Analysis", 2006.

”Does Public Debt have Strategic Value? An Empirical Analysis”, 2005.

HONORS, SCHOLARSHIPS, AND FELLOWSHIPS

Scholarship from the Swiss National Science Foundation, 2008.

Scholarship from the Swiss National Science Foundation, 2003-2004.

Member of the German National Academic Foundation, 1999-2003.

Scholarship from the German Academic Exchange Service, 1996-1997.

NON-ACADEMIC EXPERIENCE

Summer intern, The Boston Consulting Group, 2002.

REFERENCES

Michel A. Habib, Swiss Banking Institute, University of Zurich, Plattenstrasse 24, 8032 Zurich, *habib@isb.uzh.ch*.

Ulrike Malmendier, Economics Department, University of California, Berkeley, Evans Hall #3880, Berkeley, California 94720-3880, *ulrike@econ.berkeley.edu*

Alexander F. Wagner, Swiss Banking Institute, University of Zurich, Plattenstrasse 24, 8032 Zurich, *alexander.wagner@post.harvard.edu*.